# STUDIES IN THE GEOMORPHOLOGY OF EGYPT

*Prof. Mohammad Sabry Mahsoub*

Cairo 2004

# Introduction :

This book contains a series of studies that I have made during the last few years on various subjects connected with the geomorphology of Egypt.

The first four subjects deal with the coastal geomorphology of the Egyptian Islands in the Red Sea and three important parts on the Mediterranean Sea Coast - Lake Manzala Barrier, Ras El Dhabaa Area and Mersa Matrouh lagoonal area.

The final subject represents a brife general view of Bahariya Depression in the Western Desert.

The book has been supplied with more than 50 explanatory maps, diagrams and glossary including definitions of 70 terms in English and Arabic - to aid the reader in studying its content.

Finally, I would like to acknowledge the fact that material conveyed in this book relies on previous works done by me and done by others. To those people I send my thanks. dispite the reliance on previous works, I must accept responsibility for errors of expression or omission in the following pages.

*Mohamed Sabry Mahsoub*

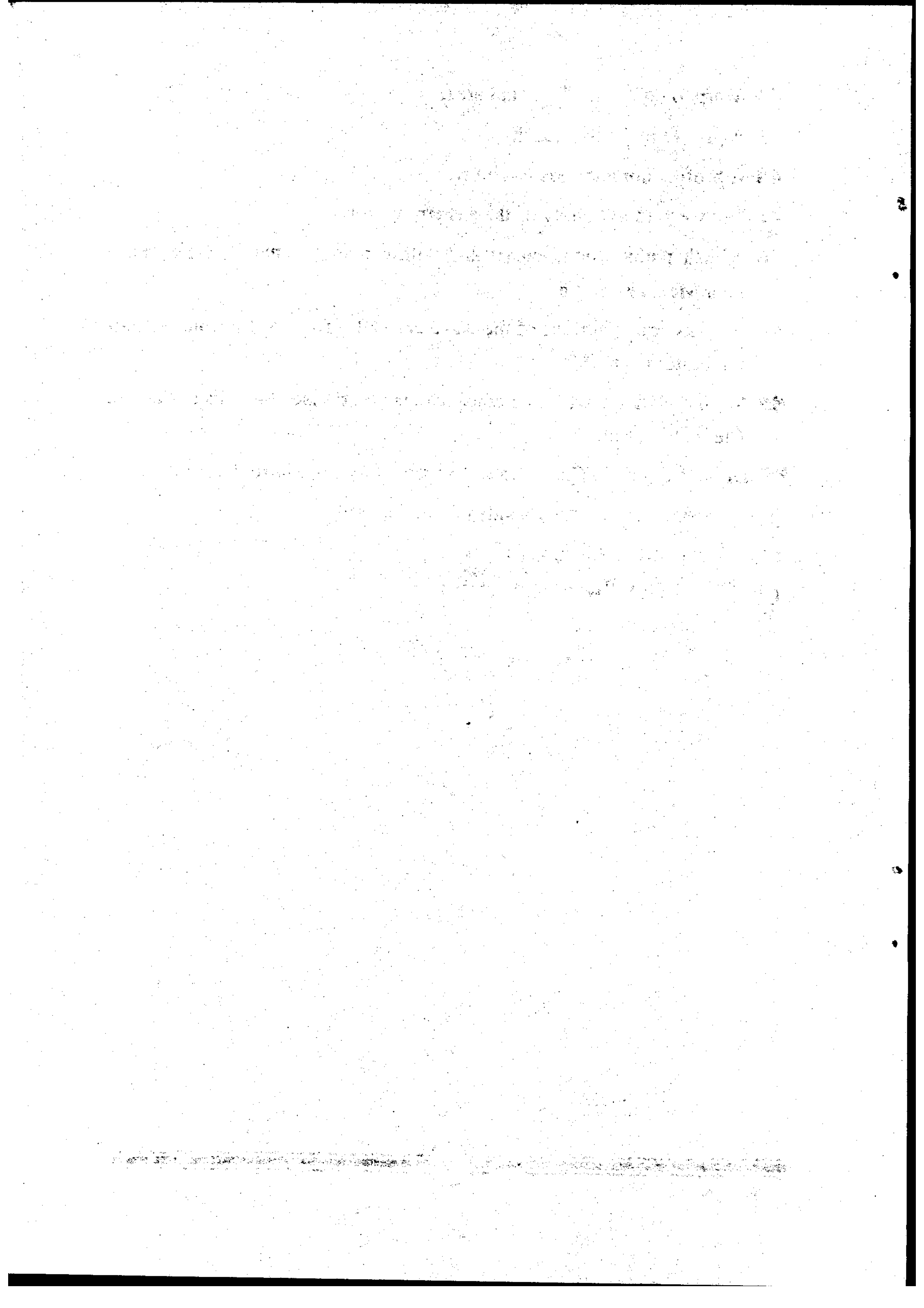
**Cai ro, April 2004**

# Contents :

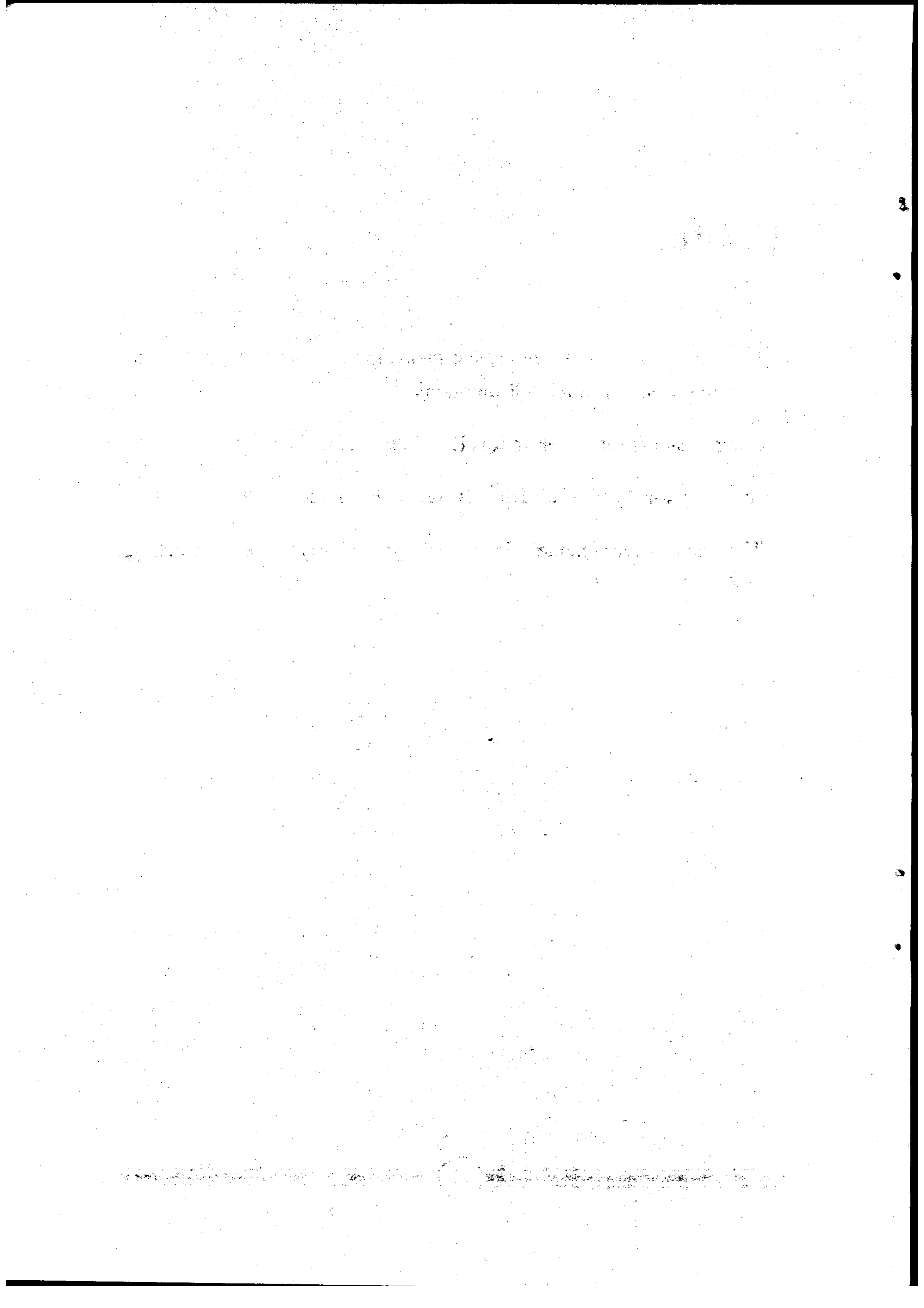
# Illustration :

22. A part of the north west triangle of the Lak Manzala barrier.
23. The development of the coast in the vicinity of Ashtoum El Gamil Inlet.
24. Sandy small islet lies adjacent the southern shore of the barrier.
25. The northern enterance of Ashtoum El Gamil inlet.
26. Ashtoum El Gamil bridge.
27. Sea wall east of Ashtoum El Gamil inlet.
28. Ras El Dhabaa.
29. The surface deposits of Ras El dhabaa area.
30. Contour map of Ras El Dhabaa Area.
31. Morphology of Ras El Dhabaa Area.
32. Diagramatic profile in the rocky cliff coast of Abu Samra.
33. Dhabaa bay fronted by tidal shallow flat and backed by sandy hummocky beach.
34. A profill along the frontal oolitic ridge near Nagaa Dhakhil.
35. Geological and topographical profile in Dhabaa Area, extends from north (shore line) to south.
36. Drainage basins of Wadi Abu Samra, Wadi Gaaber and Wadi El Dhabaa.

37. Contour map of Mersa Matrouh lagoonal area.
38. Ageeba cliffs.
39. The surface deposits in Mersa Matrouh lagoonal area.
40. Dimensions of Matrouh lagoons.
41. A profile in the southern shore of the eastern lagoon, near the governorate building.

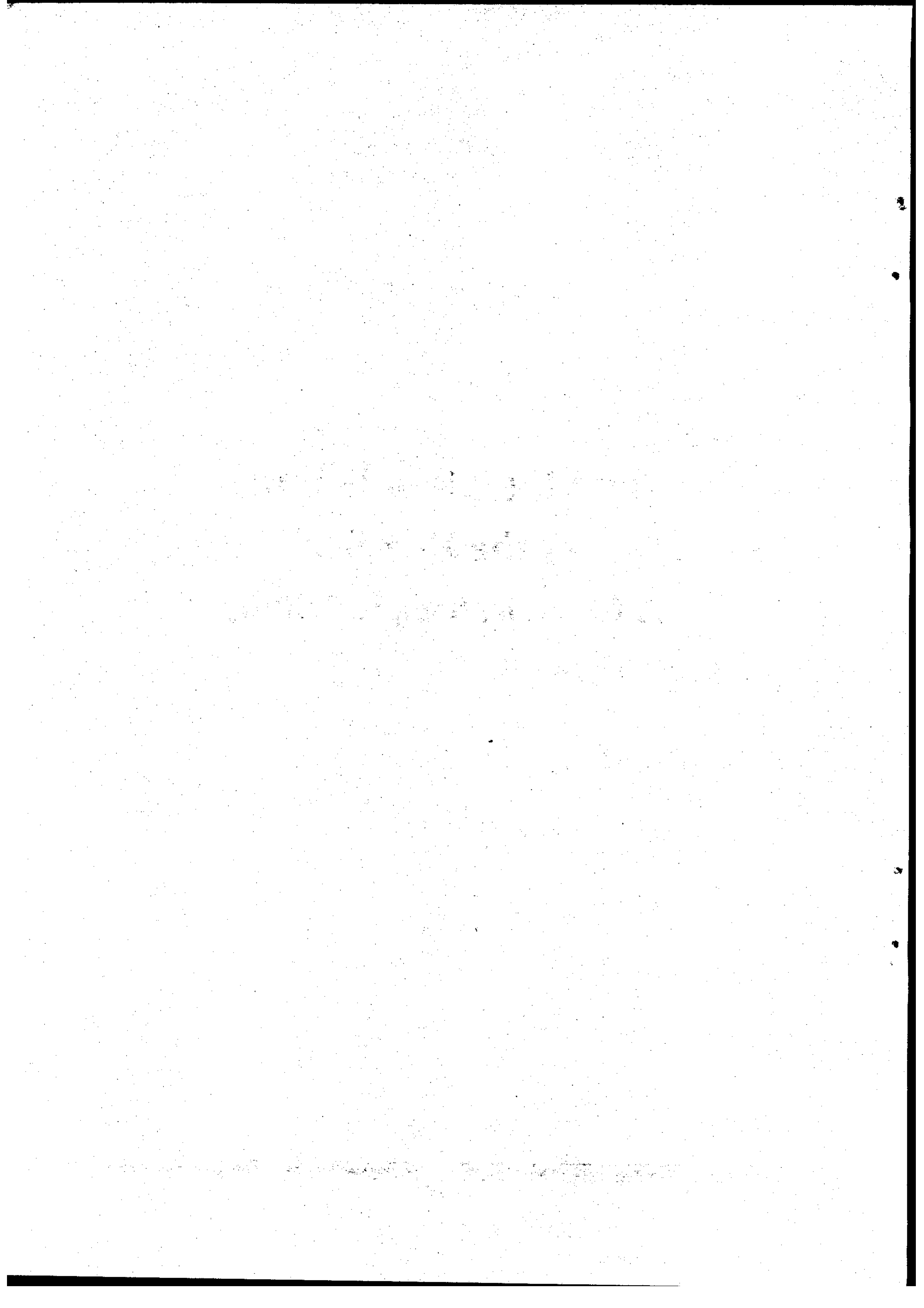


# Tables :



# The Egyptian Islands in the Red Sea

## A Geomorphological Study



# Introduction :

There are more than 40 islands and coral reef patches off shore the Red Sea coast of Egypt, the majority of them situated in the northern part, distributed in groups, the more important group is the strait of Jubal islands.

The strait of Jubal lies between the coast extending from Zeit Peninsula to Shadwan Island about 50 Km south east ward, on the south western side, and the south western coast of Sinai Peninsula extending from Knisa to Ras Mohammad about 35 km east southward on the eastern side.

The strait of Jubal covers some 3160 square kilometers of the south entrance of Suez Gulf 'it extends for a distance of more than 45 Km with average width 30 Km. Comprising sandy islands, coral reef patches and navigable channels.

The main islands in this group are Shadwan, Tawila, Ashrafii, Gubal, Qeisum and Ghanim islands (Fig. 1)

The other group of islands distributed along the coast between Hurghada and Safaga. The main islands in this group are Giftuns and Safaga island*.

* There are some islands far from the two main groups mentioned above, such as Tiran and Brothers Islands.

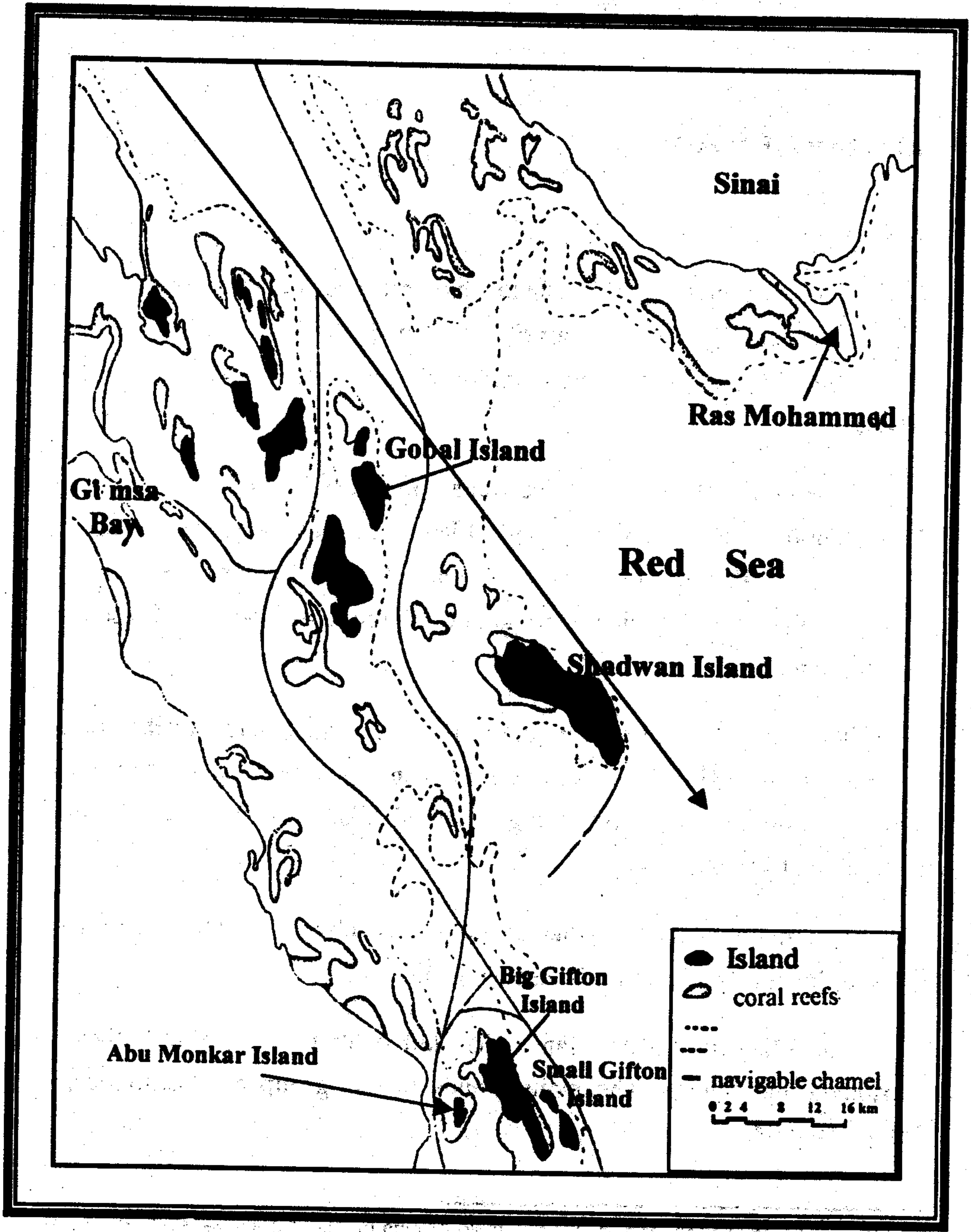



Fig. (1): Gobal Strait and its Islands and Coral Reefs

# The Geomorphology of the Min Red Sea Islands :

## Shadwan Island :

Is situated farther north between latitude 27° 32` 6" - 27° 26` 6" N and longitude 33° 53` 54" - 34° 2` 12" E (Fig. 2). It is the largest and heighest of the group of islands in the strait of Jubal and the only one which the basement complex rocks are exposed *(Shukri, N. M., 1954, p. 83)*.

The total area of Shadwan island is 42 square kilometers, with maximum length 13.5 km and width ranging between less than 2 km in the south eastern end to 4.5 km in the north west. The north western extremity of which lies about 11 km east - south - eastward of the western extremity of Tawila island. It is rugged and attains an elevation of 300 m, the hilly surface of the island is divided by ravines ; dry valleys - the sides of which are steep.

## Geologic Aspects of Shadwan Island:

The surface of the island is composed of the following geological formations.

**1. Precambrian basement complex rocks:**

Are represented by andesite, granite (igneous rocks) and metamorphic rocks such as granodiorite. The grantic rocks were later intruded by dykes of different composition.

**2. Lower eocene formation:**

Occure in the island as a small outcrops in the south eastern part of it. The sediments is about 25 meters thick formed of hard limestone.

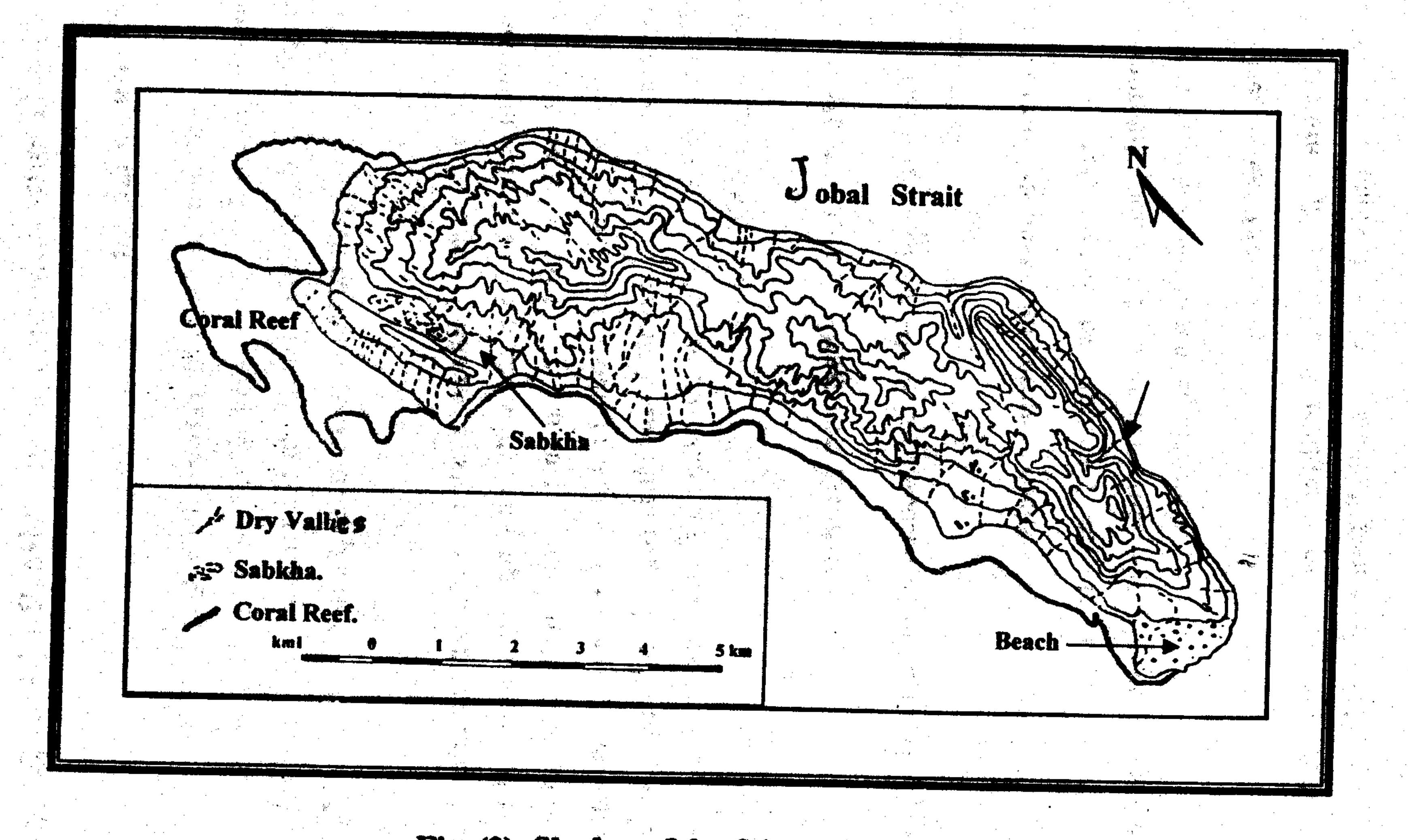



Fig. (2): Shadwan Island (contour map)

**3. Miocene formation:**

It is divided into two series. the lower series are formed of coral dolomitic reefal limestone and basal conglomerates*. The upper series are formed of evaporites ***(Shukri, N., 1952, p. 86)***, the evaporites in the island are present in three locations, in the south, west and north of the crystaline igneous, metamorphic rocks. The evaporites mainly formed of gypsum or anhydrite, it forms high scarps that are faulted in the western side.

**4. Sediments ranging from Pleistocene to Recent :**

The pliopleistocene sediments overlie the basement rocks and evaporites, and are formed of calcareous rocks and sandy limestone with thick of 300 meters. The coral limestone beds about 60 meters thick overly the pliopleistocene oolitic limestone. The pleistocene coral limestone forms raised reefal beaches in the south eastern part of Shadwan Island. The recent deposits occure as gravelly sheets, sandy gravelly beaches, reefal flats, fluvial deposits and lagoonal sediments.

The faults are the main predominant deformational structures affecting the surface of Shadwan island. They are represented by a fault escarpment on the north eastern side of the island.

## The Geomorphological Characteristics of Shadwan Islands:

The geomorphological edifice of Shadwan island is an outcome of petrology, structure, fluvial and marine processes, while climate plays a relatively limited role in this respect, that the surface of the island

* Conglomerate is some 10 meters thick, while the reefal dolomitic limestone is some 15m.

generally attains a great altitude is due to both to high resistance of igneous complex as a whole and to tectonic uplifting*.

The maximum height of the island is more than 300 meters above sea level. The elevated rugged dissected ridge extends generaly in the central part of the island from north west to south east. It represents the rugged hilly backbone of Shadwan island. The north east sides of the central ridge slope steeply toward the open deep water (Fig. 2). the eastern slope is more steeper than the western side which slope moderately toward coastal lowlying plains consist of sandy gravelly areas which located mostly as raised beaches between the footslope of the highland (central ridge) and the south shoreline of the island. The raised beaches composed of reefal limestone bounded by relatively broad fringing reefs. A reef extends about 1.6 km north westward of the north western end of the island and continues at about that distance from its south western side for about 3.5 km south eastward, the remainder of the south western side is fronted by a coral reef extending up 5 km offshore. The southern, north eastern and northern sides of the island are fringed by a coral reef extending a short distance offshore.

Low lying coastal strip extends north west between the footslope of the ridge to the shoreline. The coastal lowlying strip is occupied by inland marshes backed by micro ridge extends parallel the main elevated ridge (Fig. 2).

The elevated rugged ridge is cut by numerous ravines - minorvalley - and gullies, represents a water divide area for these valleys that drain the island high land toward the sea, pathing through steep slopes in the eastern side and through moderate gradient slopes in western sides.

* Shadwan island could be looked upon as a tilted block (tilted horst) towards the west and could be compared with Gebel Zeit near the south western coast of Gulf of Suez.

There are more than 100 minor valleys extend across the surface of the island, 44 of them extend toward the eastern direction (east north east and south east -47 wadis extend toward the western direction (Fig. 3).

The valleys and gullies in Shadwan Island are characterized by the following characteristics:

- Mosts of the valleys are fault valleys as they controlled by structural as well as lithological factors.
- The wadis in Shadwan island are characterized by their short lengths, their lengths are rangeing between 0.5 km and 5 km, due to the short distance between water divide line and the shoreline (the main base level).
- The areal photos and topographic maps show the areas of drainage basins ranging between $0.1^2$ km and $1.5^2$ km.
- The main common patterns followed by the drainage lines are dendritic, trellis and rectangular.
- There is small area near the north western end of the island characterized by its internal drainage system (Fig. 3).
- The drainage basins are characterized by high relief ratios as a result of the high density of dissection by faults and steep sided valleys, particularly on the abrupt steep eastern side of the central ridge*.



* The central ridge occupies more than 90% of the total area of Shadwan island.

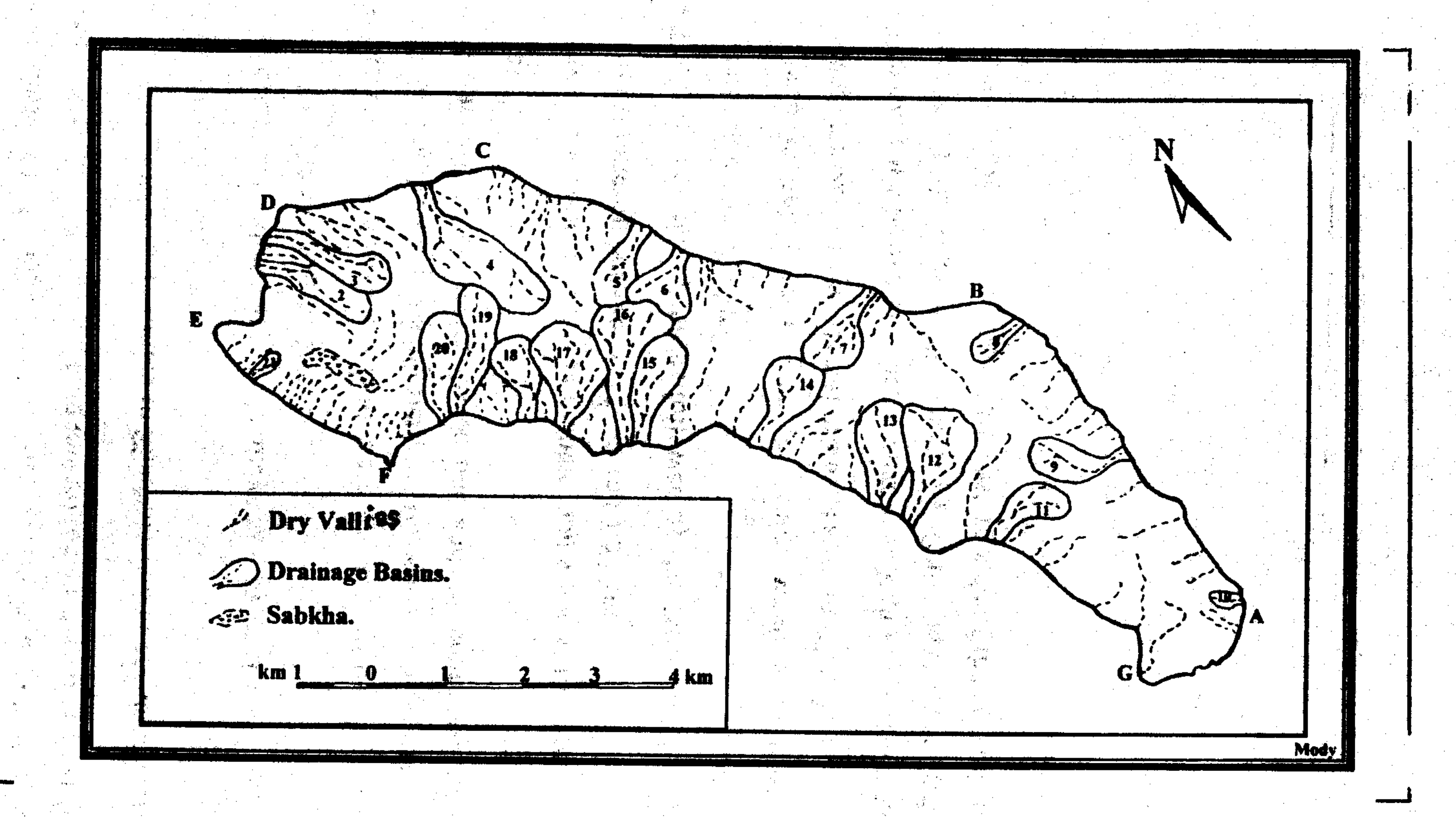



Fig. (3): Drainage Baisinsin Shadwan Island

## The Coasts of Shadwan Island anf Fringing Reefs :

The most of the coast line of the island are rocky, associated with faults in the eastern side, it slopes abruptly toward deep water of the open sea, this type of coasts is subjected by severe marine erosion which attack the eastern rocky coast of the island, producing highly erosional features - strongly controlled by geological weakness - such as caves, stacks and notches related to cliffs fronted by narrow platforms.

The main characteristics of Shadwan island coasts can be summerized as follow:

- The total length of the coastline is 40 km with sinousity ratio less than 1.3.
- The coastal strips are very narrow with sandy wide isolated patches consist of beaches, backed by raised reefs and fronted by fringing coral reefs particularly the fringing reefs which cling to the western coast of Shadwan island as can be seen in (Fig. 2).
- The fringing reef connects to shore near the water surface with width ranging between 100 meters to 500 m, It consists of a veneer (platform) of coral which at low tide is seen to be in continuity with shore or nearly so. its surface comprises a numerous microfeatures related to weathering and burrowing actions, such as creeks, hollows (ponds) sandy accumulations.

## Tiran Islnd :

Tiran island is situated at the northern end of the Red Sea on latitude 28. The strait of Tiran which joins the Red Sea with Gulf of Aqaba, lies between Tiran island and the southern coast of Sinai peninsula (Fig. 4).




Fig. (4): Tiran Island

The total area of the island is 61 square kilometers with maximum length 17 km from north west to south east and width ranging from less than 200 meters in the narrow isythmus in the north west to 8km in the central portion of the island.

The surface of Tiran island is elevated, rugged and dissected by faults and steep short wadis.

There is a narrow mountaneous elongated ridge 'extending along the southern western coast of the island, culminating in a central summit which is over 500 meters above sea level. The western half of the southern slope of the ridge is built entirely of marine terraces (Fig. 5).

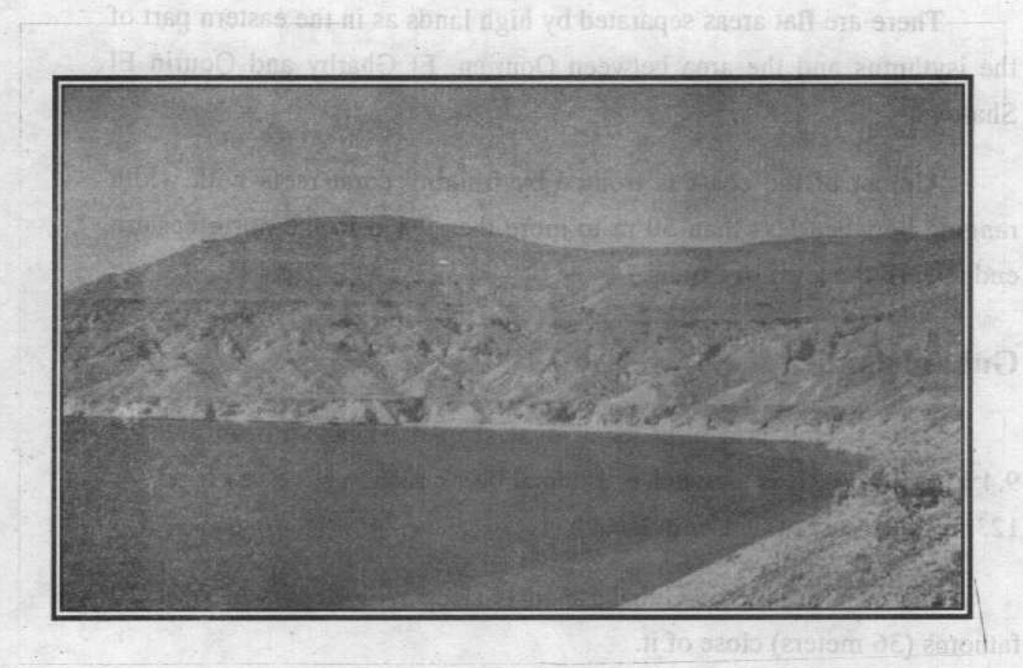


**Fig. (5): The western series of terraces on Tiran Island**

The terraces overlie on another in a stairway fashion, and the lateral extension of the series is about 6 km. The vertical range of the series is 320 m. They are built of hard coral limestone. All terraces flats are essentially level.

The entire terraced slope is deeply gullied by steep and narrow roughly parallel ravines ***(Schick, A.P., 1958, p. 63)***.

The main ridge is breached by Wadi Khushkhusha and other smaller wadis of which wadi Thamayil and wadi El Safiya.

The heighest summits in Tiran island are Tiran Mount 520 m, Ferii mount in the western part 253 m and Qurien El Gharby 177 m and Qourien El Sharqy 180 m ***(Allan, p. 43)***.

There are flat areas separated by high lands as in the eastern part of the isythmus and the area between Qourien. El Gharby and Qourin El Sharqy.

Almost of the coast is fronted by fringing coral reefs with width ranging between less than 50 m to more than 2 km in the north eastern end toward the Gulf of Aqaba.

## Gubal Island :

Gubal island is a hilly small oval shaped island with an area of $9.4^2$km (Fig. 6). It is situated as a domal block rising above sea level for 123 m south east of Queisom Island.

The eastern side of Gubal island is steep with depths of over 20 fathoms (36 meters) close of it.

The north western extremity of the island lies about a4 km east south-east ward of Qeisum island. The fringing reefs extend along the eastern and north-western coast of the island about 5 km of the northern end of Gubal island, it has some islets on it, the southern most of which is known as Gubal Saghira (Fig. 6). Gubal Saghira island is a small one with an area of 2 $km^2$, its maximum length 3 km and width ranging between 200 m and less than one kilometer.

The coasts of the island is fronted by coral reefs extending north and north west ward for 5 km

Between the south-western side of Gubal El Kabir and the north eastern side of Tawila island, the area is encumbered with rocks and shoals *(British admarality, 1967, p. 107)*.

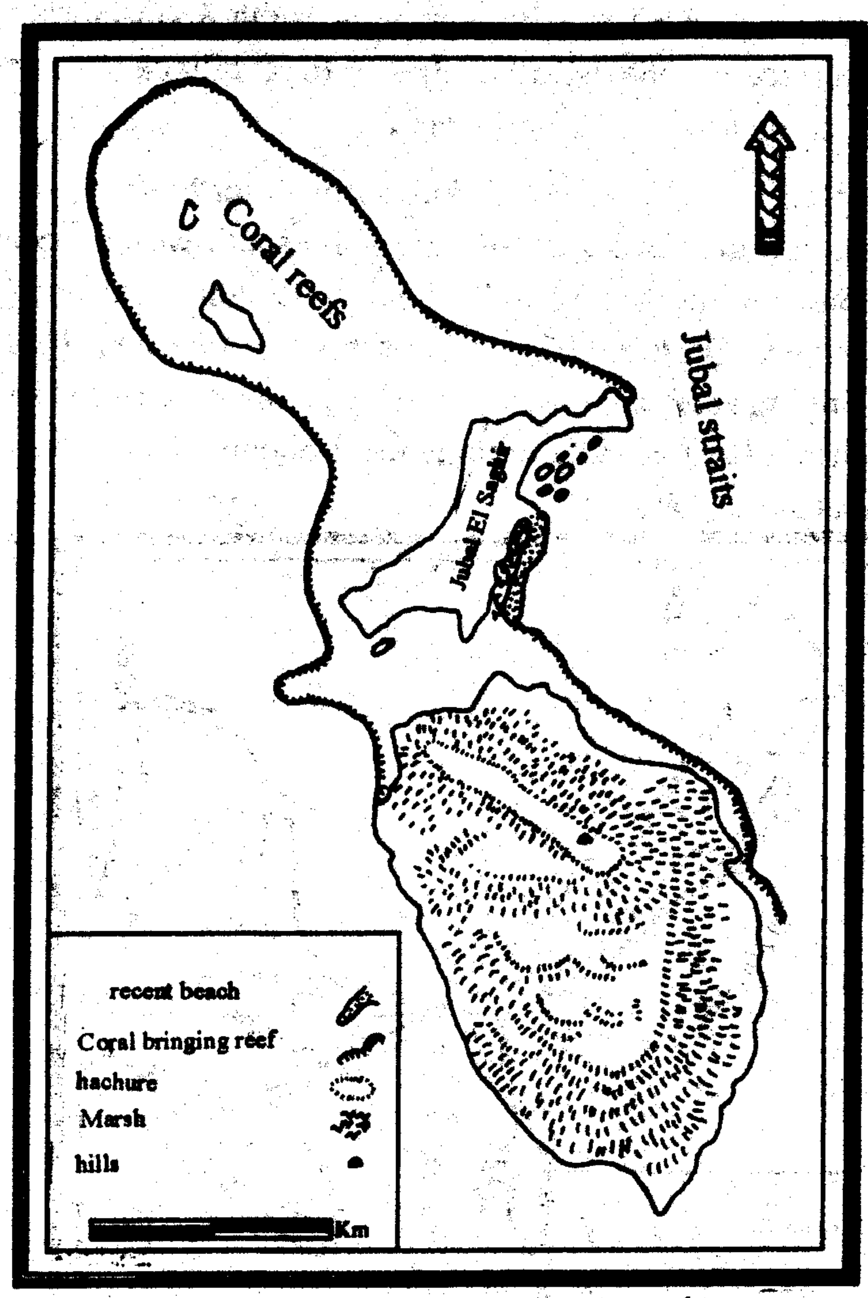



Figure (6) Jubal Island
**(J.El Kabir and J.El Saghir)**

## Northern Qeisom Island :

An elongated small sandy island, extends from north west to south east for a distance of 4.6 km, with maximum width 3 km in its northern part*. The surface of the island is flat with a hillock 17 meters in height** lies in the north east of the island.

A coral reef extends about 3 km north - north westward of the north-western end of this island, and frings its south-western coast, this coral reef connects the two islands, Qeisom El Shmalya and Qeisom Elgnobya (southern Qeisom). (Fig. 7) indicates the elongated shape of the island, the fringing reefs coral reef patches and small islets off shore the northe east coast of the island and some more above water rocks about 7 km farther south-east ward.

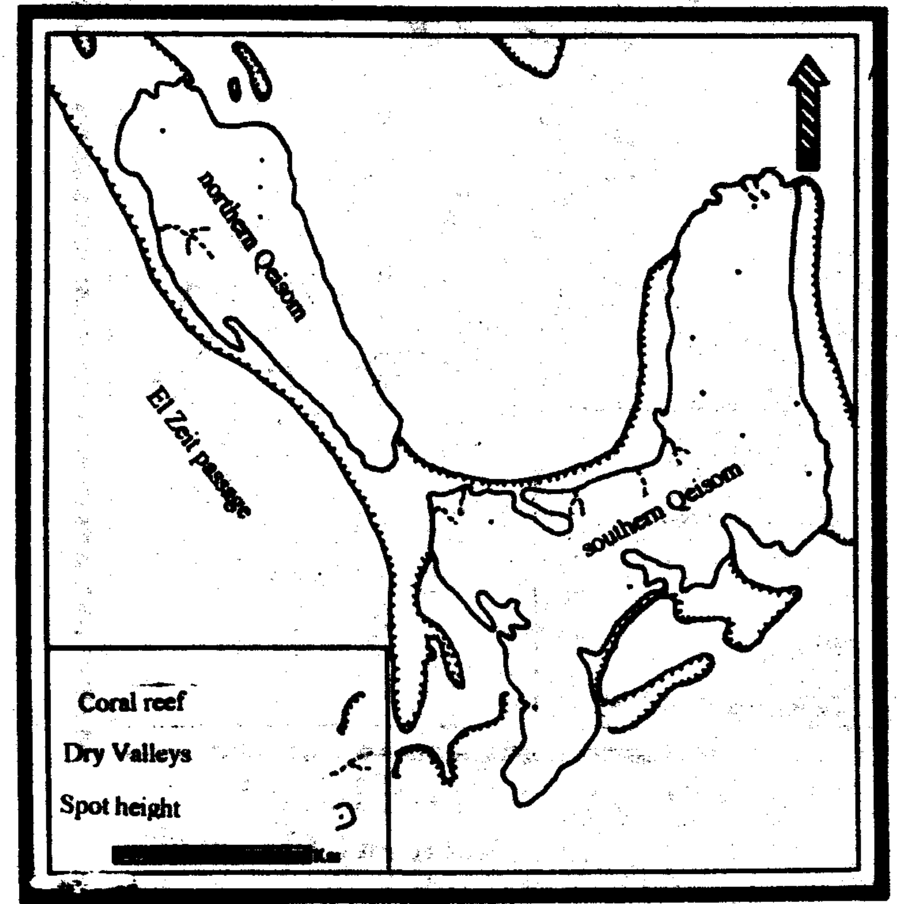



**Fig. (7): N and S Qeisom Islands**

---

* The average width of Northern Qeisom Island is about 1.6 km.

** It consists of limestone.

## Southern Qeisom Island :

The Island is a flat sandy with a dark brown conical hillock 30 m high at its north eastern end and a white sandy hillock 11 meters high about 2 km farther south ward. the northern part of South Qeisom island has white sandy cliffs consist of white arenaceous rocks from pliocene age, severly affected by marine erosion. the south west part of the island is low tidal flats.

A coral reef fringes both sides of the northern part of the island as seen in (Fig. 7). Extending about 5 km off shore at its eastern extremity and about 6 km south-south-west ward of its south western extremity while the western coast of the island is fringed with coral reefs as much as 11 km offshore. A spit with a depth of 5 meters over it, extends about 3.5 km north ward of north eastern end conecting it with Northern Qeisom island (Fig. 7).

Southern Qeisom island is irregular shaped island with total area 9.6 square kilometers. The maximum length of the island from north east to south west is more than 7 km and width ranging between 3 km to less than 0.5 km. (Fig. 7).

## Tawila Island :

Tawila island is a comparative large island with an area of more than $21^2$ km. The maximum length of the island from north to south is more than 7 km and averag width about 5 km.

The surface is generally low, flat and composed of corals, the eastern and highest part on which is a small elongated cairn from about 9 to 14 meters high.

* The elongated cairn (ridge) extends in the eastern part from north west to south east 2km long.

** Salty marshes occupy scattard patches on the western coast of Tawila island

The island is bordered by an extensive coral reef except for about 1.5 km on its eastern and south eastern coast were the fringing reef is narrow. A reefal spit with a depth of 5 meters over it extends about 2 km west ward of the north western edge of the reef (Fig. 8).

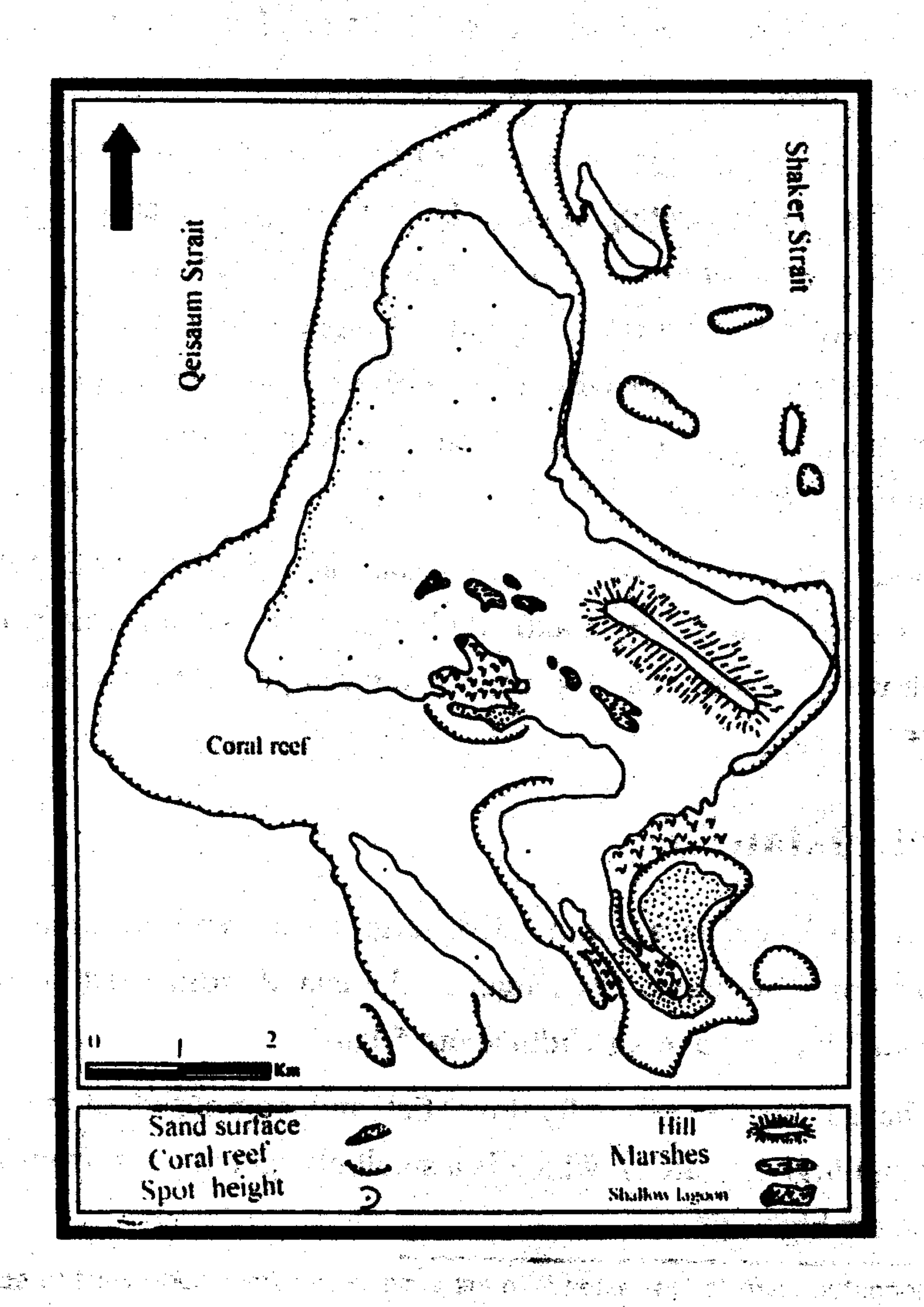



**Fig. (8) : Tawila Island**

North-east coral reef patches in hope bay lying between the north eastern side of Tawila island and the south western side of Gubal island are group of coral patches which dries in patches; shoal with a least depth of 6 m, sand and coral over it is situated about 1.5 km north-north east ward of Henderson point, the eastern extremity of Tawila island ***(British Admirality 1972, p. 107)***.

Group of coral reefs partly detached extend about 10 km south-south eastward and about 6 km south westward of the southern extremity of Tawila island*.

## Ashrafi Island and Shább Mukowarat :

Ashrafi islands (27° 47` N 33° 42` E) comprise Shább Ashrafi and Shább Mukowarat. This locality consists of three coral reefs namely the eastern shább (reef), Mukowarat and Ashrafi coral reefs.

Ashrafi island is a low (from 1 m to 4 m high) consisting of dead coral and organic reefal sands, it situated on parts of Shább Ashrafi and Shább Mukowarat (the two western reefs), as a small elongated low flat island with an area of $7.8^2$ km, maximum length 3.5 km and average width about 120 m. Ashrafi island is bordered in the east by the navigable strait namely Ashrafi strait with depths more than 30 meters (Fig. 9).

Shább Mukowarat (the centeral reef) has several islets on its northern part, terminates south ward in sandy islet (27° 43` N 33° 43` E) one meter high in its southern part is a basin called by Arab pilots Umm El Kurush with depth from 3 m to 12 m, the entrance is from eastward

* Shább Tawila, the western edge of which is situated about 6 km south westward of the southern extremity of Tawila island, covers at high tide (Fig. 9).

**Fig. (9): Ashrafi**

through a break in the coral reef about one kilometer northward of sandy islet.

The eastern reef consists of three coral patches coverd at low tide. Ashrafi channel between shàb Mukowarat and the eastern reef is deep and free from dangers in the fairway (Ibid, p. 105).

## Gifatin the Great (Giftun Kebir)

Lying off the coast in the vicinity of Franken point to a distance of about 11 km off shore is a group of islands, islets and scattered rocks.

Giftun Kebir island - the largest island of the group - is hilly rugged in its northern and central part, a rugged range (ridge) extending from its northern extremity and attaining an elevation of about 120 m. The central ridge consists of pliocenic limestone anticline, represents the eastern extension of Hurghada anticline in the mainland. The surface of Giftun kebir island was effected by faults particularly in the eastern steep dissected side. The southern part of this island is a tabeland (plateau) of dead coral with average height about 5 meters above sea level*. (Fig. 10).

The surface of the island is cut by a number of ravines, most of them are fault valleys. Dissecting** the central elongated ridge and dividing it to bare elevated hills particularly in the central part of the island (Fig. 11). The most common pattern followed by drainage lines is the dendritic pattern but the trellis and subparrallel are also represented.

* The elevation of the southern part is ranging between 2 m to 16, the dip slope toward south east is less than one degree.

** The anticlinal ridge is dissected severly by faults and wadis to separated summits extended as a water divide area along the longitudinal axis of the island.

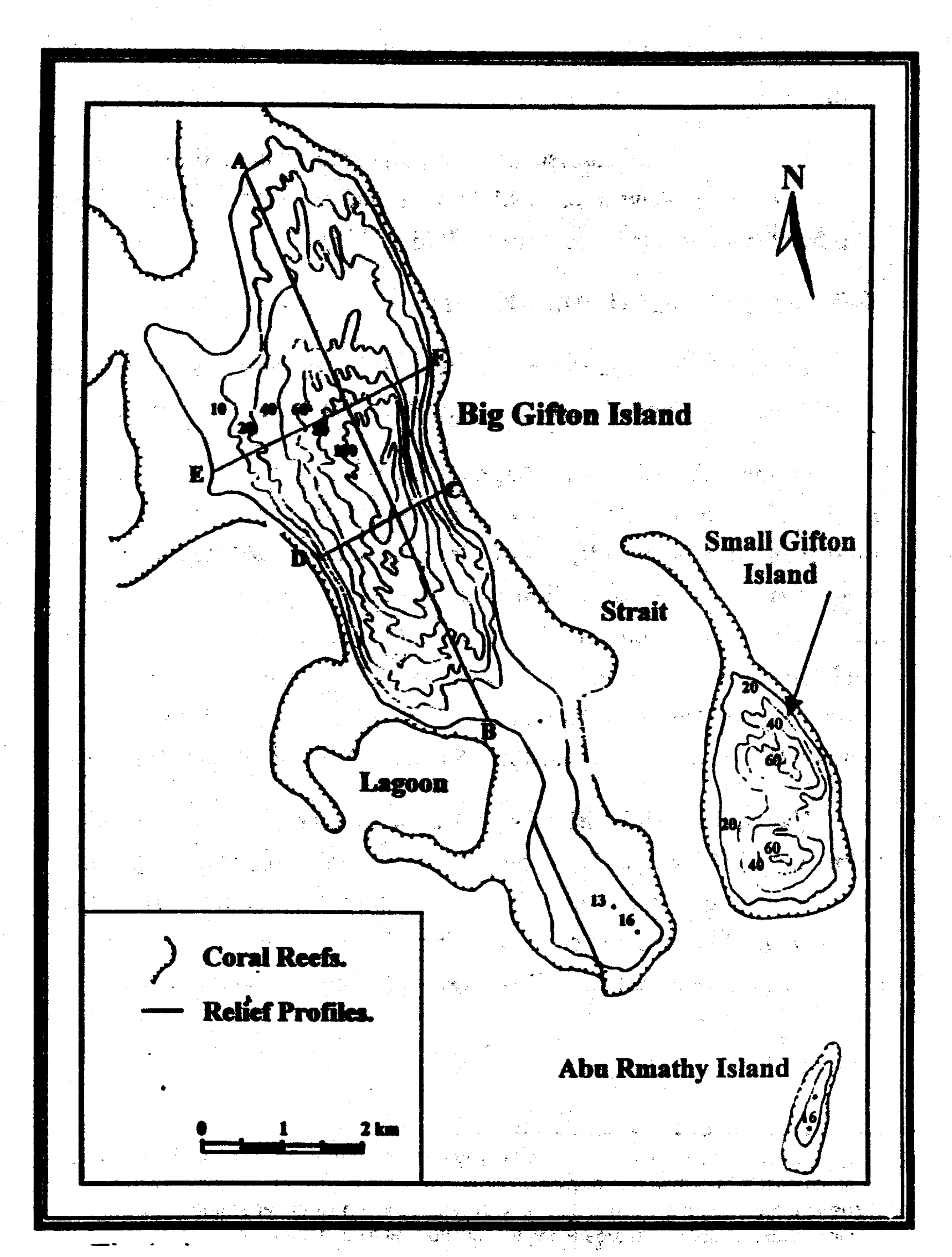



Figure (10) . Giftun El Kabir and Giftun El Saghir

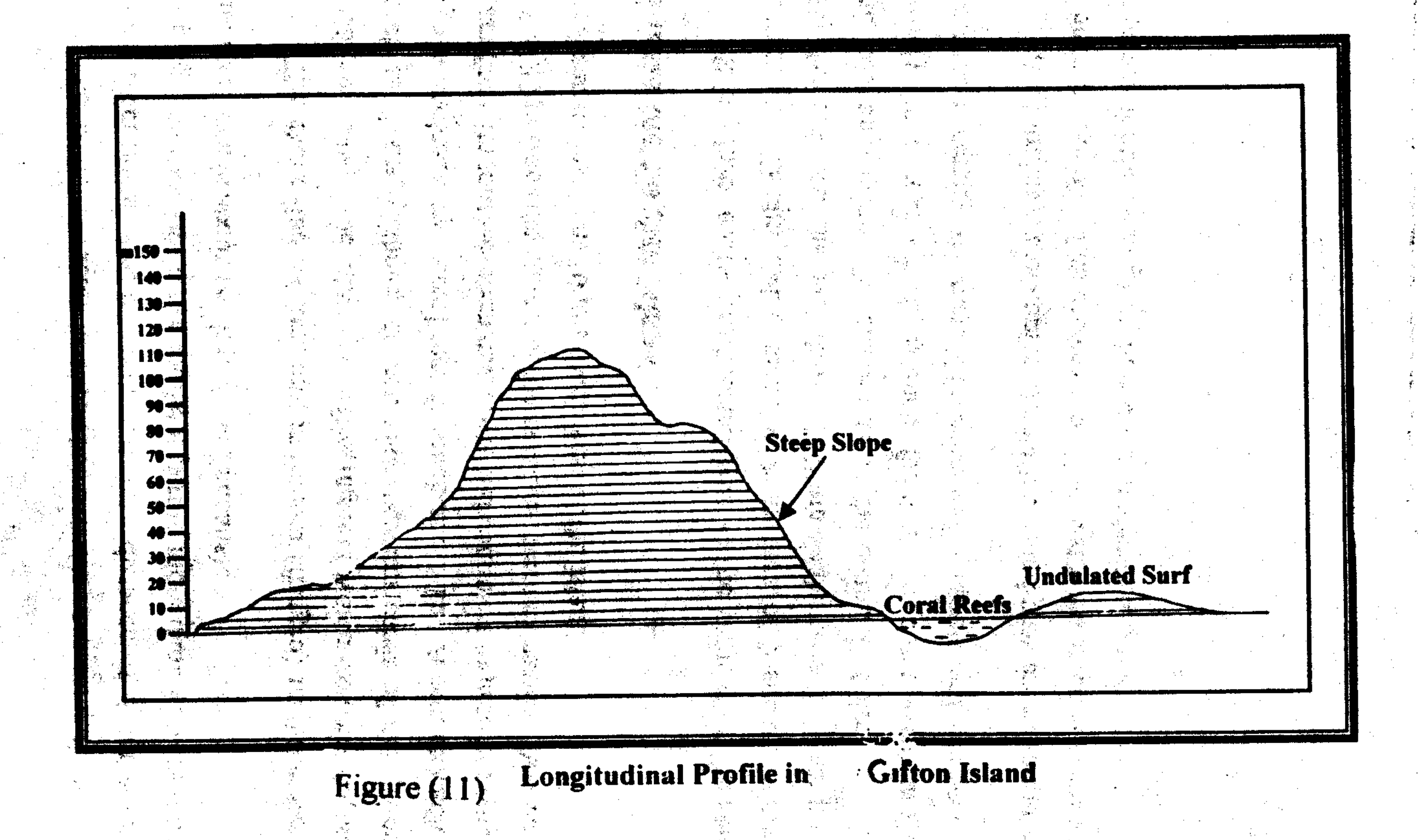



Figure (11) **Longitudinal Profile in Gifton Island**

The island as seen in Fig. (11) extends as a long hilly offshore island from north west to south east for a distance of 8 km with width ranging from 0.5 km in the southern part to more than 3 km in the north. The total area is about $18^2$ km (3950 Feddans).

The shore line 34 km long is fronted (fringed) in the eastern and southern sides of the island by a fringing reef which extends in places as much as 7 km offshore. on the south-western coast of the island is a lagoon enclosed by a coral reef as much as 1.5 km. A reef extends about 5 km from its south-eastern extremity and continues to project from about 1.5 to 2 km from the island as for as the northern extremity. A submerged coral patch lies about 10 km south west of the island.

## Gifatin the Saghir Island :

It is a hilly rocky small island lyies in the vicinity of the southern extremity of Giftun Kebir island with an area of 3 square kilometers. (Fig. 10) indicates the oval shape of Giftun Saghir with 2.75 km long and one kilometer wide. The shore line of the island is 8 km long fringed entirely by a reef which extends about 2 km north westward of its northern extremity, the eastern fringing reef is narrow and steep-to.

A central range occupies almost the island with an elevation of 100 m near the middle of its eastern side. The east ward slope is steep and the slope toward the passage in the west is moderate to gentle one.*

* The passage is a fair way, 12-29 meters in depth with average wide 1.5 km.

## Abu Rimathi :

An islet lies 3 km south ward of the south eastern extremity of Giftun Saghir, is fringed by a coral reef.

The total area of the islet is about 200.000 square meters with 1.2 k long and 120 m wide (Fig. 10).

## Umm Agawish :

An Islet composed of dead coral, with an area of 3/4 square kilometer, the northern extremity of which is situated about 5.5 km south-westward of the south western side of Giftun kebir and about 3.5 km from the main land, it is 4 m high, a ledge of submerged rocks lies about 1.5 km east ward and 2.5 km south eastward of the eastern side of the islet. A low rocky islet situated on a reef south westward of the southern end of Umm Agawish islet (Magawish) (Figure 12).

## Abu Minqar Island :

A small island situated on a reef which extends south westward from the western side of Giftun the great. It is a flat (one meter high) with an area of not more than 2 square kilometers.

Abu Minqar island composed of sand and coral debris, and divided into two parts (Fig. 12) by a narrow tidal creek borderd with a vecinia marittma (mangroves)*. The northern part of the island is bare and its southern part coverd with low bushes and halophytic plants, sandy mounds and sand sheets.

---

* Local name is Shura plant.

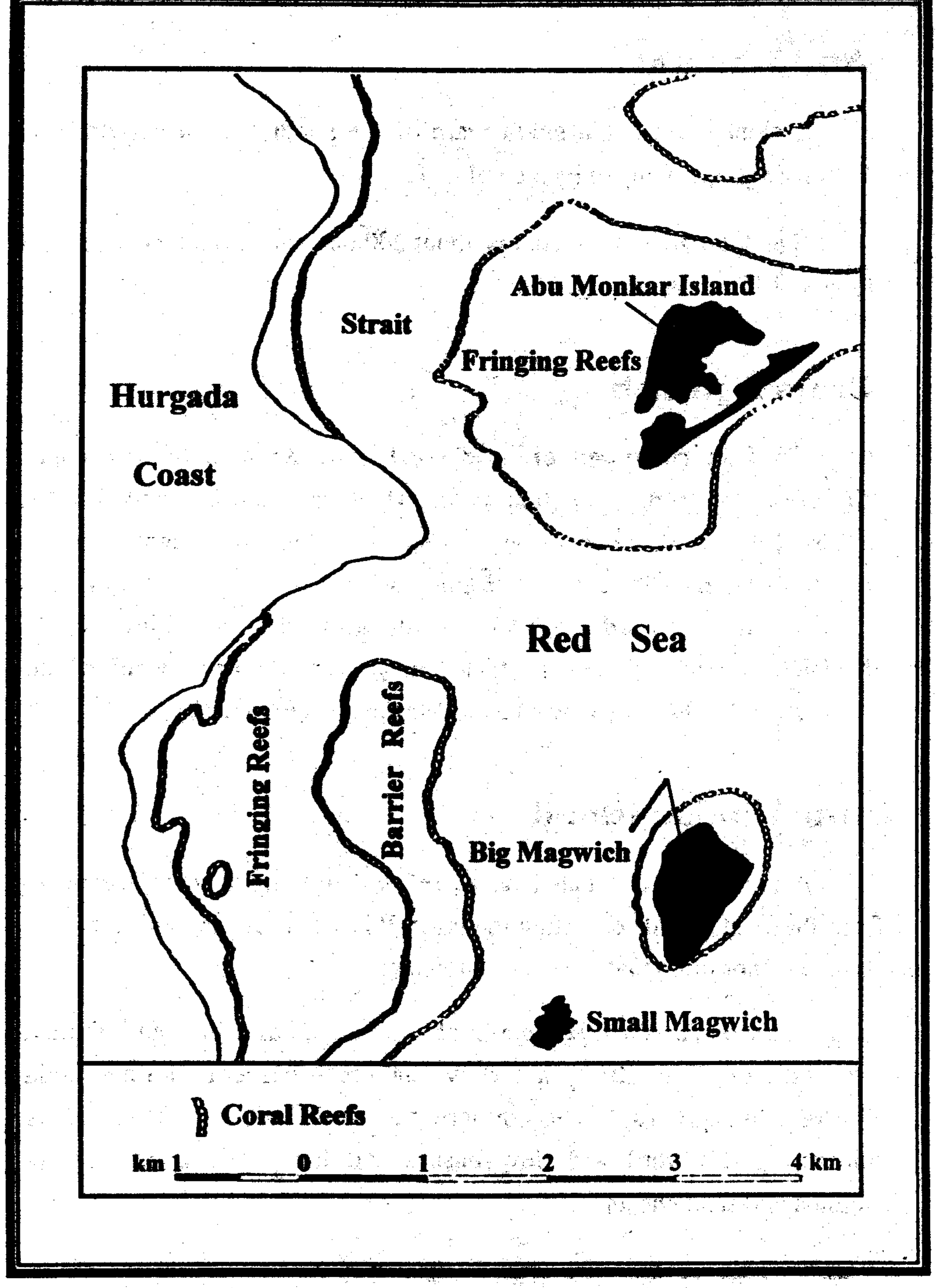



**Fig. (12): Abu Monkar and Magwish Islands**

Abu Minaqr channel lies between the mainland and the reef extending westward Abu Mingar island, 370 meter wide, and 7 meters in depth, represents a navigable channel.

## Safaga Island :

Safaga island is a flat sandy island, situated on latitude 26° 46\` south east of Ras Abu Suma, it is separated from south reef by a channel, the south western part of which is encumbered with reefs and shoals.

The total area of Safaga island is about 13 $^2$km, it is looks like an irrigular triangle with maximum length - from north to south east - more than 9 km, and average width 3.3 km. (Fig. 13).

### The Geomorphic Characteristics of The Island:

The surface of safaga island is low, sandy, with a white coloured table - topped hill 28 meters above sea level*, rising from a projection on its north eastern side. the local relief ranges between few centimeters to along the sandy coastal plains and 28 meters in the hilly part north east (Fig. 13).

* It is an isolated elevated hill 28 high in the north east part, slope steeply eastward and consists of calcareous sandy rocks.

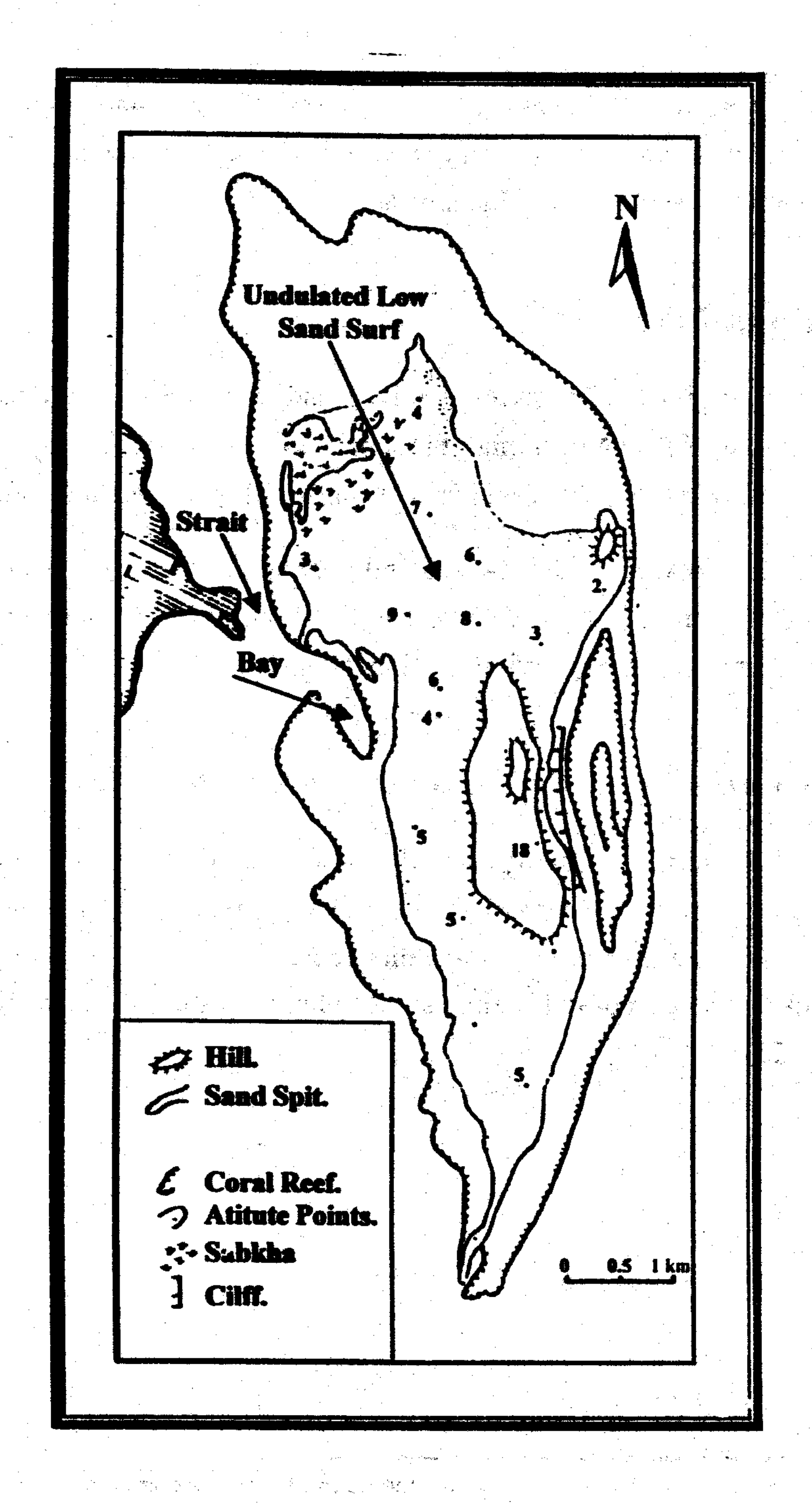



**Fig. (13): Morphology of Safaga Island**

The surface deposits consist of unconsolidated Quaternary calcareous sands. Numerous low lying saline mud flats occur immediately behined the coastline for several hundred meters inland.

The island is entirely bordered by a reef which extends about 2 km west-north westward from its northern extremity.

There is a small shallow lagoon in the north western extremity of the island with an inlet connects it the lagoon - withe the sea (Fig. 13). Spit reef extends about 6 km south west ward*.

There is a narrow shallow channal between the mainland and the north western coast of Safaga island, there is a bar cross it, with maximum depth of 3 meters.

## Tubya Islets :

Consist of two islets lying on a coral reef. The northern islet is a small sandy low, lies 6 km north of safaga island. It is elongated in shape, extends for a distance of half km only from north to south with average width 200m.

The elevation of the surface ranges between one to 2 meters above the sea level.

The southern islet at the southern end of the coral reef is smaller than the northern islet (Figure 14). It is low lying flat, covered with sands and coral debris.

Between the north-eastern side of this coral reef and the reef bordering the southern end of peninsula of Abu Suma are some rocks a wash. The coastal reef, on which lies a small cay, extends few kilometers

* The total lengths of coast line of Safaga island is more than 35 km. Thes shore line particularly the western one is indented by sandy bays.

off shore, north - westward of Tubya sandy islets. There is a passage between North Fairway reef and sandy islet *(British Admiralty, 1972, p. 171).*

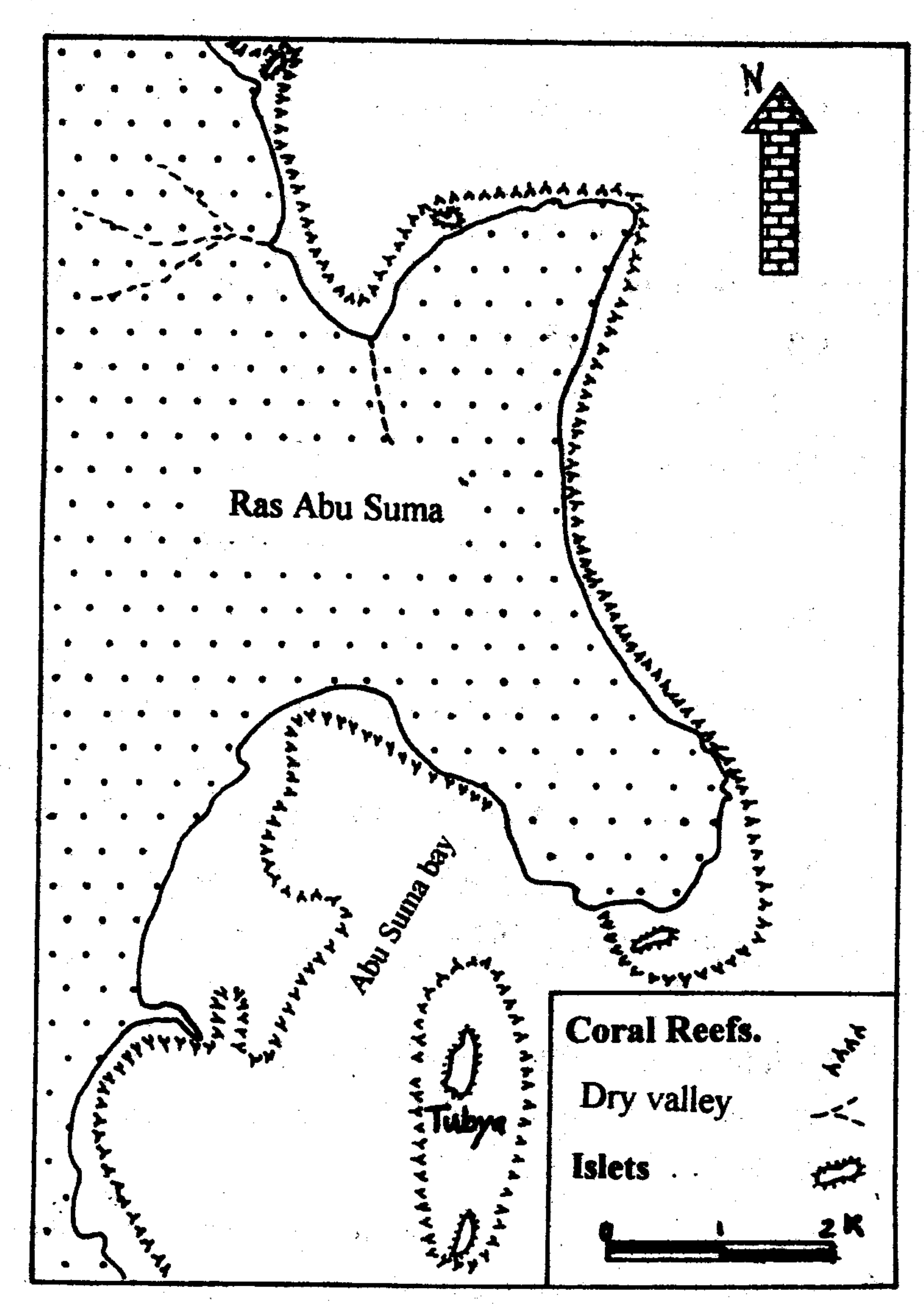



**Fig. (14): Ras Suma and Tubya Islet**

## Umm El Gurssan Islet :

A small sandy flat islet looks like Tubya islet, lies in the vicinity of the southern extremity of Abu Suma peninsula rises over coral reef flat as seen in (Figure. 14).

The Islets offshore the cost between Baghdady headland and Banas peninsula are characterized by small areas and low surfaces. the main islets offshore, this sector of the Egyptian Red Sea coast are:

## Wadi El Gimal Islet:

A small crescentic flat islet, situated on Latitude 24° 40` North, Longitude 35° 10` East.

It is a low rocky islet with total area of less than 3 square kilometers. The north-eastern end of W. El Gimal islet appears as a low cliff from south east-ward, while from south ward both ends of this islet appear low with the summit in the middle.

The longitudinal axis of the islet extends from north to south for 4.25 kilometers and the width is ranging between 800 m in the south to 1.2 km in the northern extremity.

The islet is entirely fringed with coral reef. Two detached rugged rocks with depths of less than 2 m over them, lie about 10 km and 6 km respectively north-north-eastward of the northern extremity of the islet and a similar rock lies 7 km east-north eastward of the eastern extremity.

As the locality of the islet is fronted by vigorously growing fringing reefs* and scttared submerged rocks, the area as a whole should be approached with great caution within a distance of 16 kilometers. ***(British Admirality, 1972, p. 179).***

* The protection received from fringing reefs reduces wave action and tidal currents.

The channel between the mainland - Red sea coast - and the western coast of Wadi El Gimal islet is encumbered with rocks and can only be used by small boats with local knowledge.

## Qulaan Islands :

The group of Qulaan islands consists of four small islands lie on a bank extending about 6 km north eastward from the coast in the vicinity of Qulaan headland (Ras Qulaan) and thence about 13 km north - north westward. The northern most of this group is Siyal Islet, is situated about 8 km north ward of Qulaan headland and about 5 km off shore. Siyal Islet, one kilometer long, 200 m wide, has an area of 220.000 square meters. The total length of coast line is more than 2.7 km. Showarit islet lies south east of Mahabis islet, on which there is a cover of palm trees and scattered bushes of xerophytic plants. Mahabis islet (south island) is the southern most. Nomerous rocks with depths of less than 2 m over them, lie on this bank. The passage* between the mainland and the group of Qulaan islets is encumbered with reefs (Figure 15).

## Offshore Islands Along the Coast from Banas Peninsula to Halayeb Headland :

Mokawar Islet lies 6 km south-south-east of Ras Banas as a terminate extremity of this headland. Mokawar islet is a coral cay, covered with sands, derived from limestone. It is 33 m high at its southern end and on south westerly bearings appears as an inclined plane, the islet as we mentioned is of coral and is fringed by a steep - to coral reef which extends about one kilometer north - westward of its northern end (Figure 16) Rocky minor islet lies about 14 km south westward mikauwa islet, a bank with depths of up to 60 m over it and on which are

* Two detached reefs lie on the northern side of the channel within the enterance, reducing the width of the navigable channel.

several rocks and shoals with dipths of less than 2 m over them extends about 7.5 km north east ward and 3.2 km south south-westward of the minor rocky islet (Figure 16).

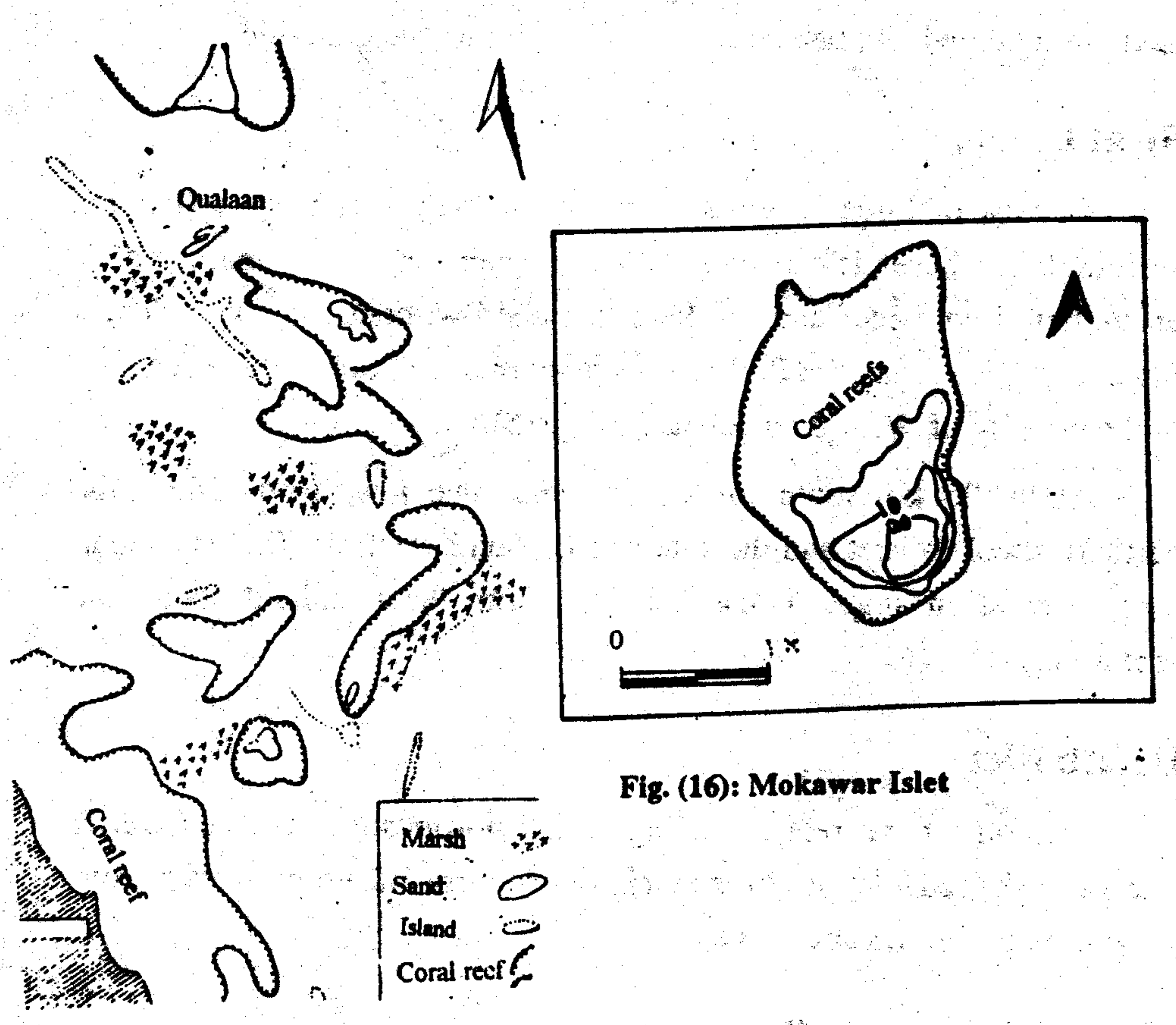



Fig. (15): Qulaan Islets

Fig. (16): Mokawar Islet

The surface is generaly low tends to increase in elevation toward the south to reach 36 m above sea level,

## Mirear Islet:

Situdated as a flat low sandy islet about 30 km south eastward of Bodkin reef.

The total area of Mirear islet is less than 1.5 square kilometers, with maximum length from east to west about 2 kilometers. The coasts of the islet are indented and liable to inundations during the high tide.

## Siyal Islets :

Consist of three sandy islets partly covered with bushes, the area surrounding these islets and between them and the mainland is encumbered with reef and not be approached without local knowledge. Siyal islets lies along the Red Sea coast south of 33° 30` latitude (cancer) in the vicinity of W. A dieb debouch (Fig. 15).

About 25 km south east of the coast two low, sandy islets, the northern kwolala islet and the southern is Halaib islet, the first is a small islet, circular in shape, it has been cut from the mainland about one century ago.

## Halaib islet

Lies on a coral reef extending 11 km northward of the coast. It is triangular shaped islet lies in the vicinity of Mersa Halaib protects it from the marine processes and surges.

## Islands of the Deep Waters :

These types of islands represent in three small islands situated in the open sea deep water far from the mainland - the Egyptian Red Sea coast - for a distance ranges of 40 to 60 kilmeters.

## Zabargad Island :

It is a small, barren waterless island situated about 42 km south eastward of Ras Banas, is steep rugged rocky island, 234 m high, the hill in its center is a conical peak of volcanic origin. The island is fringed by vigorously growing fringing coral reef with steep edges slope abruptly toward the deep water with depths ranges from 500 to 1000 m.

The island is inaccessible, except for a narrow passage through the fringing reef on the north - eastern side.

The total area of Zabargad island is about 12 square kilometers. Rocky islet lying about 5 km south east ward of the south east of Zabargad island, is small, rugged, steep and rocky.

## El Akhawin Islets :

Situated in the deep water south east of Shadwan island for a distance of 120 kilometers, and about 48 km from the south western shore of the Red Sea, consist of two almost steep coral islets. North islet and southern islet which are separated from each other by a channel about 1.5 km wide. Both islets are bordered by coral reefs, a reefal spit extends north westward of the northern extremity of south islet.

The two islets are of volcanic origin as Zabargad island, looks like atolls in the tropical areas of oceans.

## Dedalus Coral Reef :

(Abu El Kizan) lying about 160 km south south eastward of El Akhawin islets and about 50 km from the western shore of the Red sea. It composed of coral reefs liable to inundations during the high tide periods.

# References :

1. Alam, A., (2001), The Geomorphology of Aqaba Gulf Enterance, Monofyia Univ. (in Arabic).

2. Abdel Gawad, A (1969): Geological Structures of the Red Sea area inferared from satilite pictures - edited by Degens and Ross, New York.

3. British Admirality (1967): Red Sea and Gulf of Aden Pilot, London.

4. Crossland, C., (1939): Some Coral formations, Publications of marine biological station Hurghada, No. 1, pp. 20-30.

5. ---------------, et al (1939): Topography of the Red Sea floor publications of biologcial stations, Hurghada.

6. Edwards, A. J. and Head, S. (1987): Key Environments - Red Sea .

7. Malty. S. (1968): Suez Gulf "a study in regional geography," unpublished M. Thesis - Cairo University (in Arabic).

8. Salim, M. S. (1979): Red Sea Coast between Ras Gemsa in the north and Ras Banas in the south a study in physical geography, pH. D. Cairo University (in Arabic).

9. Salim, M. S. (1994): Coasts of Egypt, Cairo, (in Arabic).

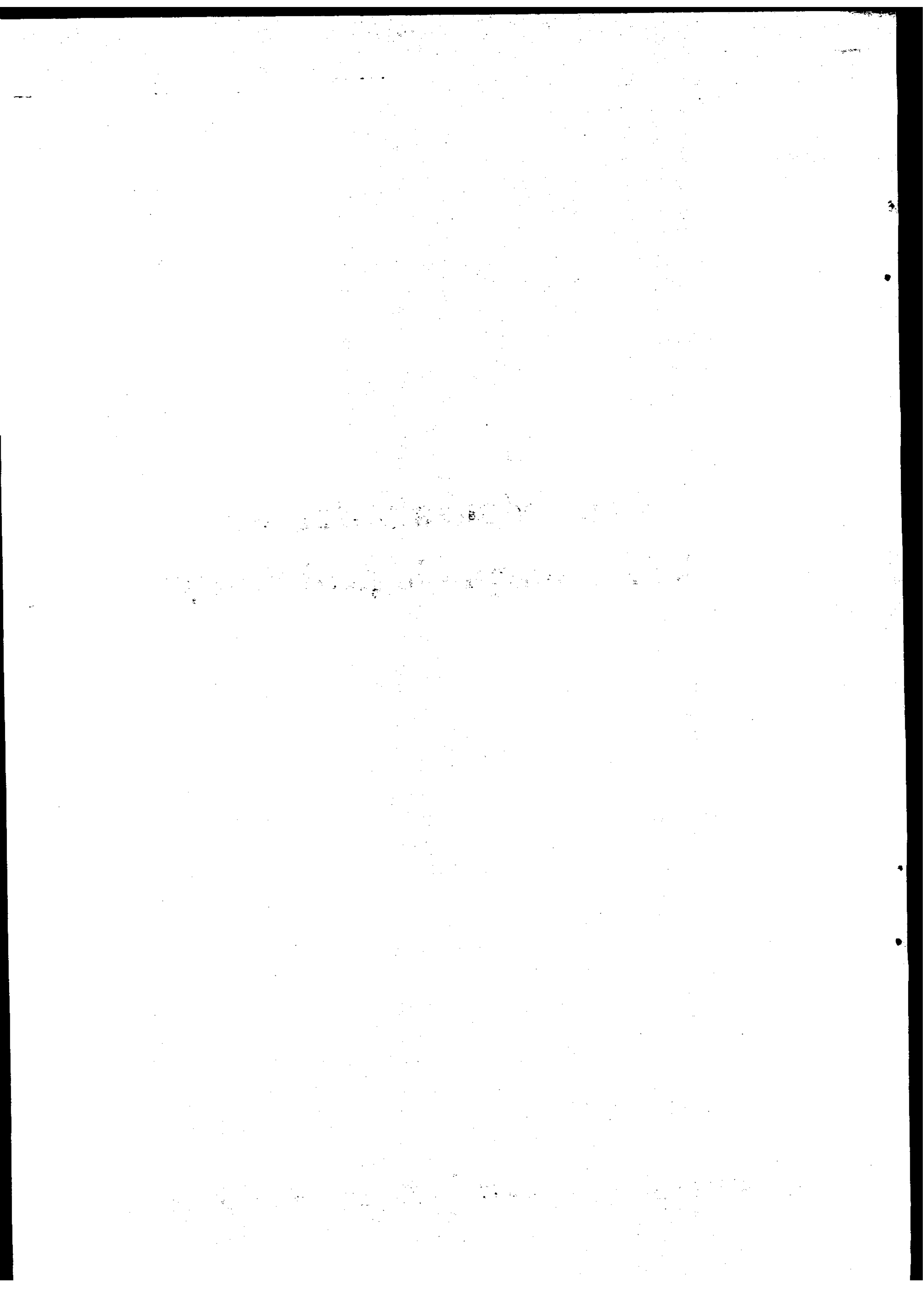
10. Salim, M.S. (1998): Physical Geography of Egypt - The Geomorphological aspects, Cairo (in Arabic).

11. Schick, A. (1958): Marine Terraces on Tiran Island Northern Red Sea, Geogr Annaler, Stockholm.

12. Shukri, N. M. (1954) The Geology of Shadwan Island Northern Red Sea, Bull d'l Soc. De Geogr. D' Egypte, Tome XXVII.

13. Sunamra, T., (1993): Geomorphology of Rocky Coasts, Sinpore.

# Lake Manzala Berrier
# A Geomorphological Study



# Lake Manzala Barrier

## A Geomorphological Study

This study deals with the geomorphic characteristics and the main features of Lake Manzala barrier.

The sandy compound barrier is located parallel to the present shore line, separating Lake Manzala from the Mediterranean sea.

It extends from Damitta branch mouth, south east ward for a distance of more than 50 kilometers and with total area of about 50 square kilometers. The width of the barrier is ranging between 150 meters, in the west side of Ashtoum el Gamil inlet (Boghaz) to more than 2 kilometers in north west end near Damietta promontory.

The barrier is characterized by its low lying surface, with maximum height less than 2 meteres above mean sea level and very gentle slope toward the sea - less than two degrees - with sandy flats and without any rock exposure.

The sandy barrier is interrupted by a narrow and very shallow straits (inlets) connecting the Lake Manzala with the Mediterranean sea (Figure 17).

The shore line accretion is positioned to the east of the eroding promontory of Damietta branch mouth. This pattern is a response to an eastward drift of sidements resulting from the prevailing North North-West waves and east ward flowing longshore current ***(Omara, et al., 1993)***.

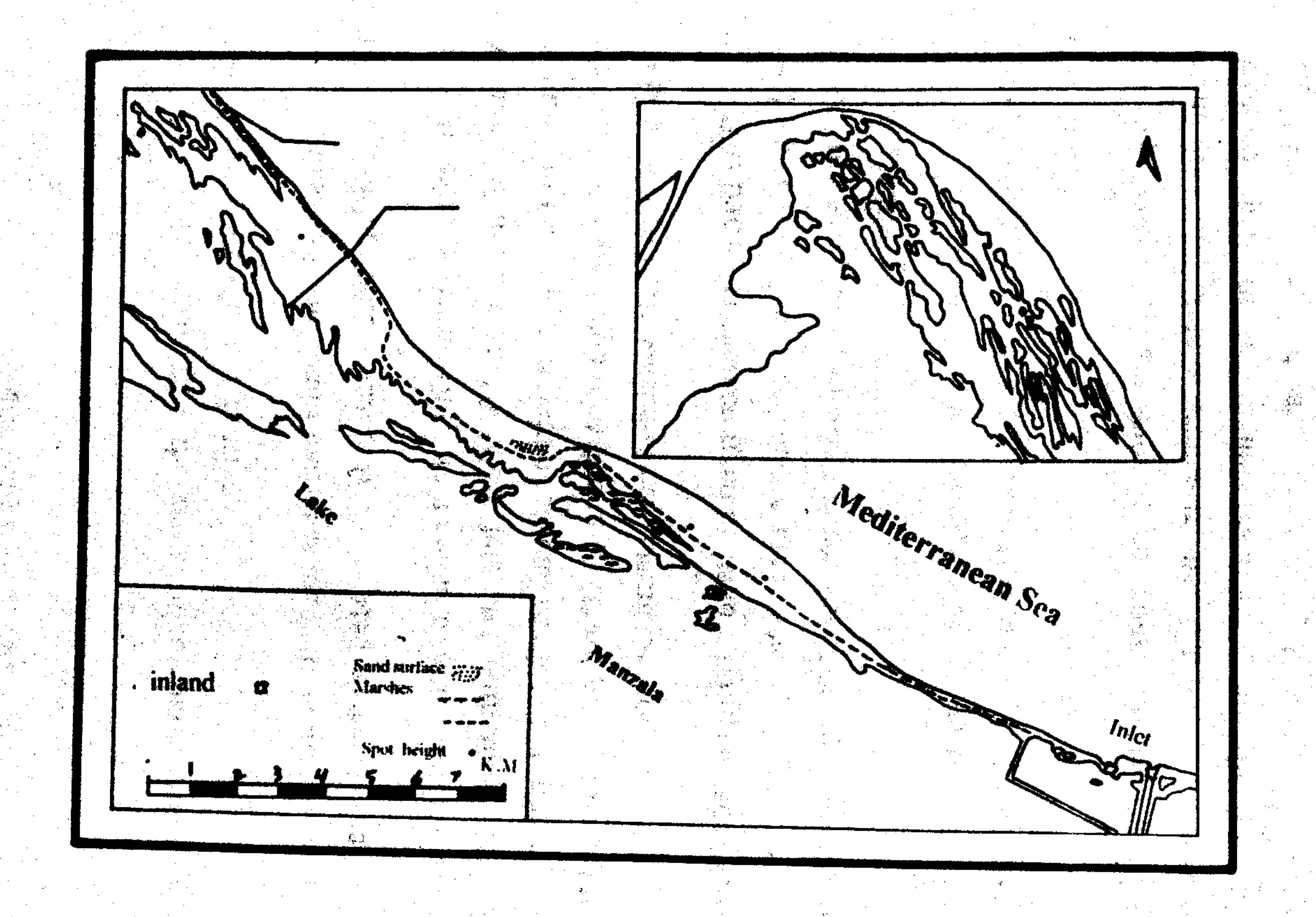



Fig. (17): LakeManzala Barrier

## Geomorphic Processes and their Effects on the Barrier :

The marine processes play important roles on the geomorphic features of the Lake Manzala Barrier.

The effect of marine processes related to waves, tides, littoral currents on the area under investigation can be summerized in the following analysis.

## Wave action :

It ws found that wave action on the shore line of the barrier is seasonal in nature and strongly related to large scale pressure systems *(Khafagy and Manohar, 1979)*. It was found that the year can be divided into three seasons *(Fanos, A., et al., 1993)* namely winter, spring and summer. The winter known to be the stormy season from mid October to March. The Spring (April nd May) and the Summer known to be the swell (domal shape) season from June to mid October (Figure 18) indicates to wave refraction on the coast of the barrier.

The measurements and invistigations have reveald that the dynamic factors affecting the processes that shape the coast along the sandy low lying shore line of the barrier are the waves. Wave height of about 70 centimeters are average for the coast.

During the storm season - the Winter - the average wave height is 150 centimeters. The maximum wave height recorded during 1976 and 1980 was 2.2 meters with wave periods (wave frequency) ranging from 5 to 6 seconds.

---

(1) This type of waves are destructive particularly along the extremity of Damietta promontory which is subjected to erosion.

The predominant directions of waves during the Winter season - the stormy one - are North - North West particularly during the surges (October and March).

It is clear that wave characteristics are varying from season to season and from year to year, these variations cause the change of wave energy flux, which is primarily responsible for nearshore coastal changes *(Fanos, A, et al. 1993, p. 3)* The western shoreline of Damietta promontory is - as we mentioned - subjected to severe erosion and quarrying by the waves that attack this exposed side of the promontory.

The accretion occurs on the eastern side forming Damietta sandy curved spit*, in the northern west end of the barrier (Figure 13). The source for the accreted sediments east of Damietta spit and other places of accretion may be related mostly to the areas of the inner shelf (near shore shallow waters) and partly to the eroded sediments from the frontal extremity of Damietta promontory which move as long shore drifts south east ward *(UNDP, 1978)*.

## Littoral Currents :

The predominant current direction along the littoral shallow waters between breaking line** - breaking zon up to 3 meters depths - and shore line is from west to east except in some few months (March, Aporil and May) where the current reverses its directions depending on the wind wave directions and submerged relief.

The maximum velocity of the littoral currents along the shore of the barrier in the shallow littoral zone between 3.5 meters and 6 meters in

* Coastal Protection Studies (1978), reported that erosion and accretion (deposition) merely seem to change places depending upon the submarine bars and wave characteristics.

** The water beyond the breaking zone is up to 6 meters.

deph is 40 centimeters per second, and average velocity 10 centimeters per second (manohar, M., 1981, pp. 8-15), velocity of the littoral current reaches its maximum near Ashtoum El Gamil Inlet (Boughaz) due to the flow of water through it.

Beyond the breaking zone (5 to 15 m depths) there are type of surface currents move along the coast, mixed with gyers near mouth of Damietta branch.*

The table (1) indicates the velocity of these currents east of Damietta promontory, along the shore line of the barrier and in the sea side of A Shloum el Gamil Inlet.

**Table (1)**: The current velocities beyond the breaking zone of the Lake Manzala barrier, east of Damietta promontory

| Distance/m | East of Damietta Promonlory | Along the shorline | Ashtoum el Gamil Inlet |
|---|---|---|---|
| 200 | 19 cm/sec | 10 cm/sec | 10 |
| 400 | 23 | 25 | 18 |
| 800 | 32 | 40 | 5 |

(Tetra Tech, 1984)

* The littoral currents and related gyers influence the sediments movements and shaping the coast up on the intensity and direction of these currents.

## Tides :

The tidal range along the sea shore of the barrier is less than 30 centimeters in average. The maximum in port-Said is 1.32 meters, and near Ras El Bar 1.8 m.

Tides affect the work done by wind waves Particulkarly during the time of wave storms (surges).

More important is the interchange of water between the lake Manzala and the sea through the Ashtoum El Gamil inlet (Boughaz) as a tidal current.

There are many land forms influenced by the tides and tidal currents, the more pronouncing are marshes which occupy the low lying sites,. associated with micro tidal features such as tidal creeks, ponds berms and algal flats.

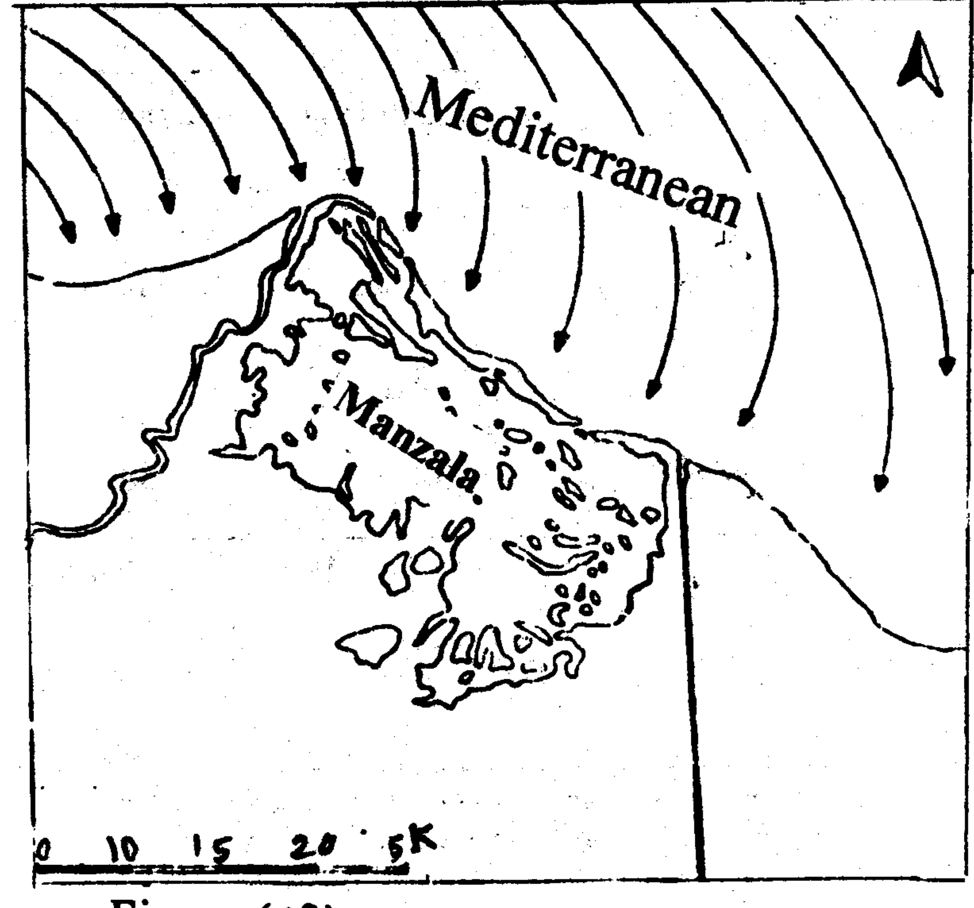



Figure ( 18)

## The Geomorphic units of the barrier and related features:

## Introduction :

Lake Manzala barrier extends from Damietta branch mouth, south east ward to Port Said city for a distance of more than 55 Kilometers, separates Lake Manzala from the Mediterranean sea.

The barrier is permanentaly subjected to severe erosion by marine processes related to waves, littoral currents and surging at the seaward side. It consists of a series of several small sandy bars, have been developed under the accretion of sediments in between forming the compound barrier of Lake Manzala as seen clearly at the north western part of the barrier with average width more than 2 km. The general morphology of the barrier has clearly gone through successive erosional and depositional phases of marine processes which had modified both surface forms and shoreline configuration (Figure 17).

The total area of the barrier surface is about 40 square kilometers, it is mostly a backshore plain comprising marshes, low impeded frontal dunes and longitudinal low sandy ridges extend in general parallel to the shoreline, covered with vegitation.

A large part of the low flat plains between the low sandy dunes (nebkaas) is essentially flooded by the sea water - subjected to inundation - and was over sand features are observed locally in so many locallities particularly in the vicinity of the inlet of Ashtoum el Gamil and neare Deebaa town.

The barrier is dissected by three narrow straits (inlets) trough which the lake water is connected with sea water.

**The barrier of Lake Manzala can be divided into three geomorphic units as follow:**

## The Surface :

The surface of the barrier is low, flat sandy strip, stretches south eastwards as far as Port Said city, for a distance of more than 55 kilometers. It composed mainly of medium - grained yellowish brown will sorted sands, components include quartze, heavey minerals and shell fragments. The thickness of these deposits dimenishes from west to east south east.

At all sites the sands lie above lagoonal deposits and the contact between the two sets of deposits is probably erosional one, had modified during the emergence phase (Arbouille, D. and Stanley, D., 1990, p.50).

The surface of the barrier consists of sereis of sandy elongated bars alternated with small isolated very shallow depressions - shoals - at the northern western parts of the barrier - at the eastern side of Damietta promontory (Figure 19). These areas are partly covered by lateral inundation from the lake and sea during the high tide.

The south east stretch of the surface tends to be narrow particularly near the western side of Ashtoum el Gamil inlet (Boughaz) about 180 meters in width (Figure 17).

The small wet swamps are extending as longitudinal small shallow water bodies parallel with the sandy bars in the north western part, from Halg el Gamal Site 31° 50` longitude to 32° L.

The longitudinal marshes are varying in there areas and their dimensions (Figure 20) with common depths less than one meter, this wet

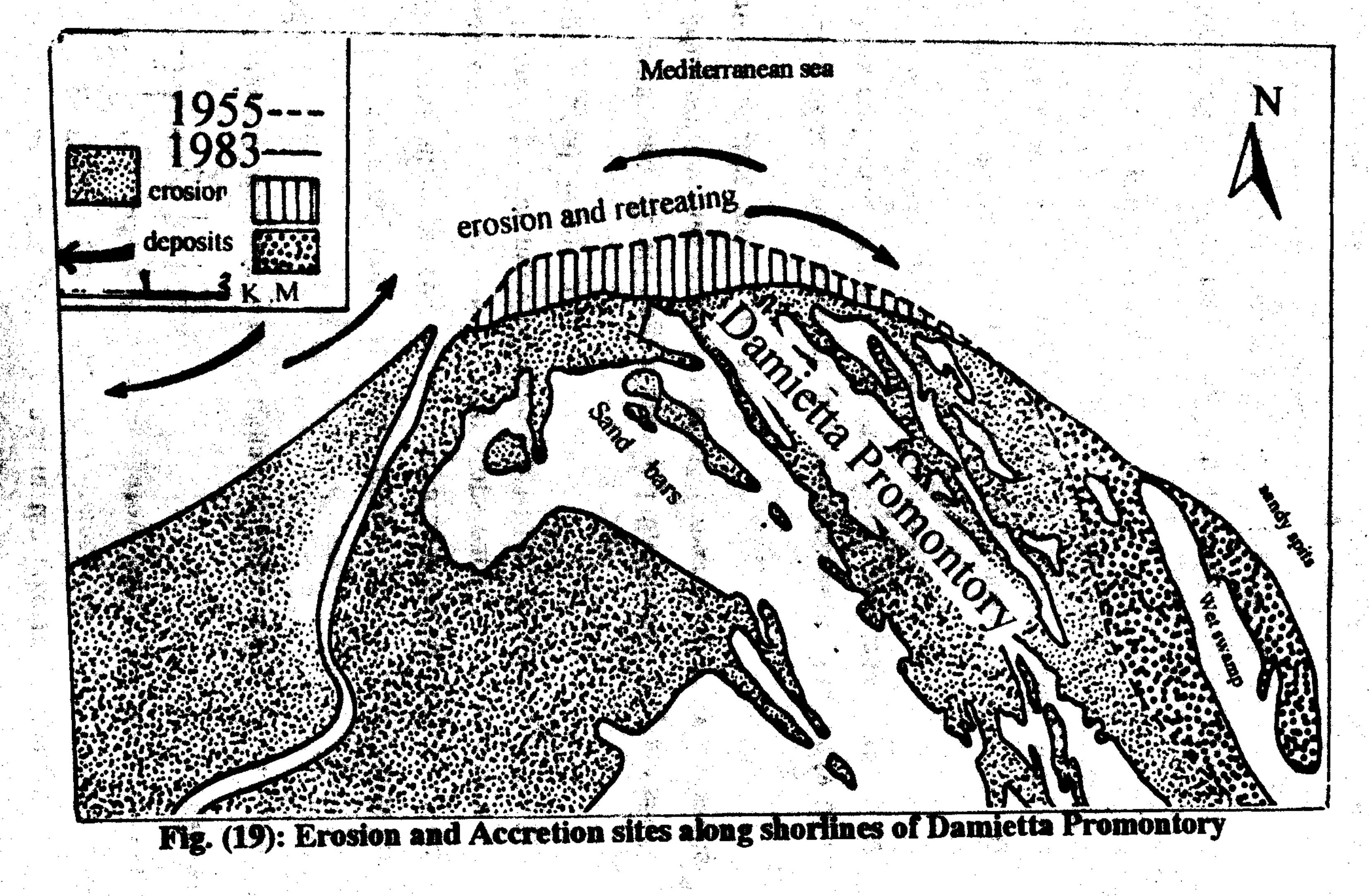



Fig. (19): Erosion and Accretion sites along shorlines of Damietta Promontory

areas is permanently subjected to the inundation during high tides, surges in addition to the excess water drained in the lake from channels and drains (Bah El Bagar, Hadous and other drains). The water floods this part of the low flat surface through the narrow boaghaz namely Sorgan opening and Ashtoum Baghdady.

The lagoonal deposits (wet sabakha and salt marshes) include mud sand and silt.

Many of the sandy bars - elongated islands - in the nourth western part of the main barrier are covered by vegitation and hydrophyte grasses. The sandy bars extend as sandy linear strips parallel with the shorline east of Damietta poromontory between Bar El Dhahr and Bar el Krakah near Halg el Gamal (Figure 20).

The sandy bars are varying in areas and dimensions, they are sandy flattish strips without any exposure rocks* (covered etntirely by sands and vegitated sabakha and salt marshes).

Patches of salt crusts occur in the bare areas above the sandy bars. The numbers and areas of he sandy longitudinal bars tend to dimenish toward the south east stretches as seen in (Figure 21).

The main large bars (twaal) represent in island of Sidi Baghdady which extends as an elongated comparative large bars** south of Deeba village from east to west with total area about one square kilometer, it tends to dimenish in width east ward.

A longitudinal swamp ranges in width between one kilometer and 250 meters separates Sidi Baghdady island from the main barrier.

---

* The bars loak like the main barrier in surface appearance (natural land scape).

** These bars are growing in size and most of them were joined with each other to form elongated bars.

## Some forms above the surface of the barrier:

The most common featurs above the surface of the main barrier are depositional forms.

A few hillocks covered by halophytic plants (nebbaks) rise from the surfuce plain of the barrier in the narrow part between Deeba village and the western side of Ashtoum el Gamil inlet. These sandy low hillocks - nebbaks - in addition to sandy impeded elongated ridges are located in coastal sabakha areas where the depth of water is about few centimeters *(Zaghlol, 1997, p. 144)*.

Few small primary frontal dunes are found near Deeba village, extend parallel to the shore line from west north to south east. These sandy forms are subjected to inundation during the exceptional inundation of the wave storms (surges) and permanently are affected by the wave sprays and excess relative humidity. The sands in this area are interpreted primirly as shallow marine to coastal deposits, medium to coarse grained derived from sand beaches which extend along the shoreline as a low, relative broad berms, not more than 30 cedntimeters in height.

### The Northern Shorline (Sea Side) :

The shoreline of the barrier is sandy, flat and is liable to inundation. It stretches generally east south ward from Damietta branch mouth to Port Said city as a strip of very low sand for a distance of more than 55 kilometers which separates Lake Manzala from the sea.

Along the shor line - sea side - of the barrier there are three marine factors affect the process of accretional and depositional forms and the configuration of the shore line itself.

The geomorphic processes depend on several variables, for example shoreline orientations, wind velocity the lowlying surface of the sandy fore shore and the sources of materials (sediments).

Inspection of images and topographic maps reveal the presence of depositional features along the shoreline, particularly along the north western segment of the barrier, 15 kilometers in length (Figure 20).

Damiatta promontory is the main significant coastal form along the shore line from the mouth of Damietta branch to Port Said City in the east.

This promontory was built up since the tenth century AD *(CRI / UNDP / UNSCO, 1978)*.

The Nile sediments, directed toward the west and east sides of Damietta branch under the action of sea waves, built this area. The promontory has advanced about three kilometers in the period between 1800 and around 1900.

The progressive widening and the increasing length of the promontory had been continued to around 1900 when it began its retreating *(Fanos, S.A. et al., 1989, p. 5)*.

The erosion was quite severe at the shore line of the promontory from 1895 to 1988, accretion in the eastern side caused by the longshore drift toward south east.

The shore line of Damietta promontory is composed of sandy deposits, it extends south eastward flanked by intertidal flats and sandy beaches backed by sabakha. the Sabakhas are protected from the sea by sandy spit.

## Damietta Spit :

Both low tidal amplitude and the protection recieved from the spit and sunken sandy bars reduce wave action and tidal currents in this locality - Sabakha area in the eastern side of the promontory - which is going to be closed entirely by the sandy spit (Figure 19) as a significant sedimentary environment on this coast.

One of the significant depositional feature along the shore line of the barrier is Damietta sandy spit.

Damietta spit lies on the eastern side of Damietta promontory extends east ward subparallel with shoreline for more than five kilometers as a compound subparallel low sandy curved strip, enclosing elongated very shallow lagoon covered with halophytic plants and hydrophytic grasses which trap sediments derived from the near shore or from the - sites - of retreating subjected to erosion in the north west extremity of the promontory, some of the sands were driven by currents toward the lagoon through its enterance causes silting up and rising its floor.

The sandy curved spit was developed by offshore currents and by longshore drift due to the wave refraction and tidal currents in the shallow littoral Zone (Figure 19).

Bight of Deeba - Diba*- is a slight curvature in the shoreline, lies 32° 10` E - 31` 32° N between Damietta Mouth and Port Said. The tore shore of Deeba is sandy flat, liable to inundation, composed of blak sands mixed with fine grained mud.

* Fort El Deeba 31° 31` N - 32° 40` E stands in ruins at the ancient Mendesian mouth of River Nile now closed. A second fort (5 Km south south west of the first) appears as a flat - topped sand mound is used as a coast guard station (British Admirality, 1976, p. 117).

## The Shore line changes :

The sea side shore line of Lake Manzala barrier between Damietta and Port Said is characterised by accretion in some sites causing progression toward the sea and erosion - retreating - in other sites.

(Figure 20) shows the shore line changes between 1955 and 1983.

Figure 21 indicates to the development of the western profile of the shoreline from 1935 to 1988.

## The sites of retreating :

Shore line retreating as a result of erosion are represented in the following sites:

- ***Damietta promontory front*** :

This site had been retreated about 1300 meters between 1857 and 1922 with annual rate 20 meters.

The annual rate of retreating increased to 31 meters during the period between 1955 - 1983 (Figure 20).

- ***South east of Damietta spit*** :

South east of Damietta spit for more than 20 kilometers, the shore line had been retreated 3000 meters (3 km) between 1950 and 1983.

The annual rate of retreating along this profile of shoreline is about 40 meters (Figure 21).

- ***Deeba shore line*** :

The shore line in bight of Deeba (Diba) had been retreated with annual rates more than the sites mentioned above due to the severe erosion related to waves and active tidal currents.

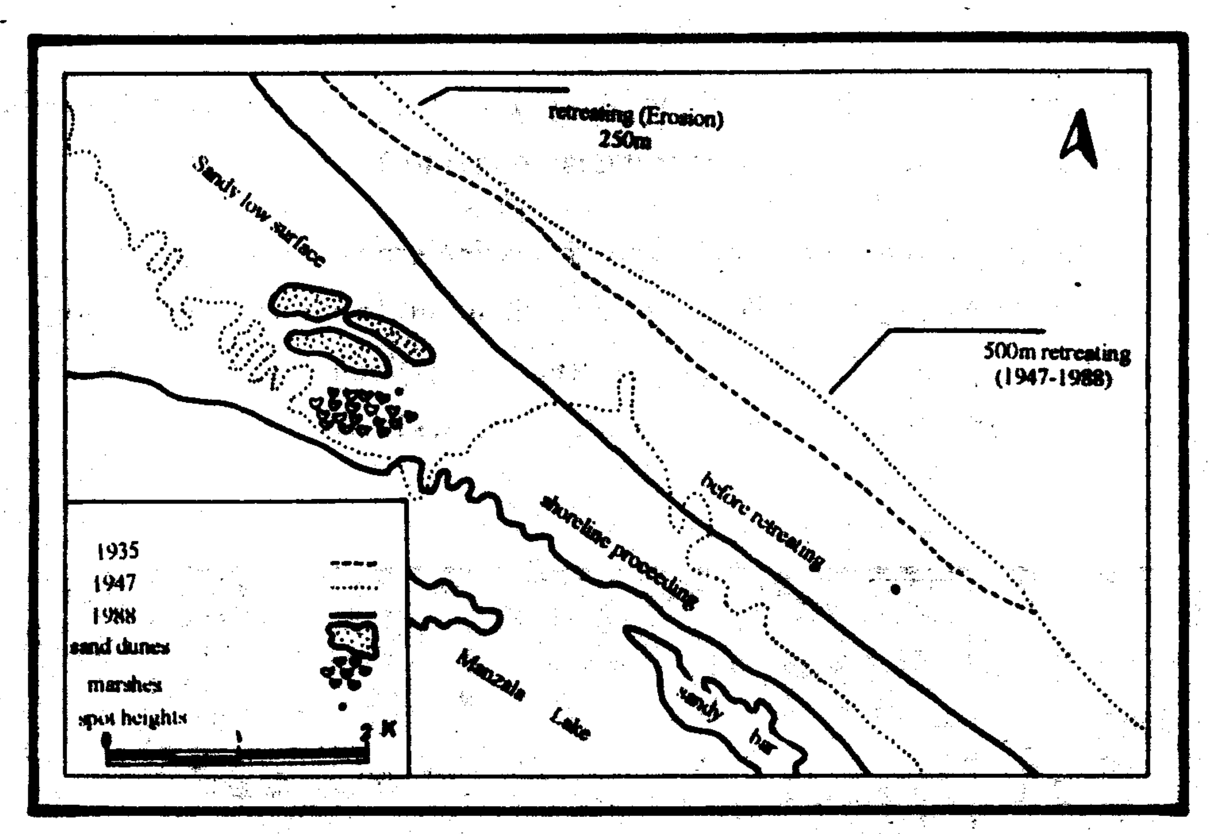



**Fig. (20): Shoreline changes between 1935 and 1988**

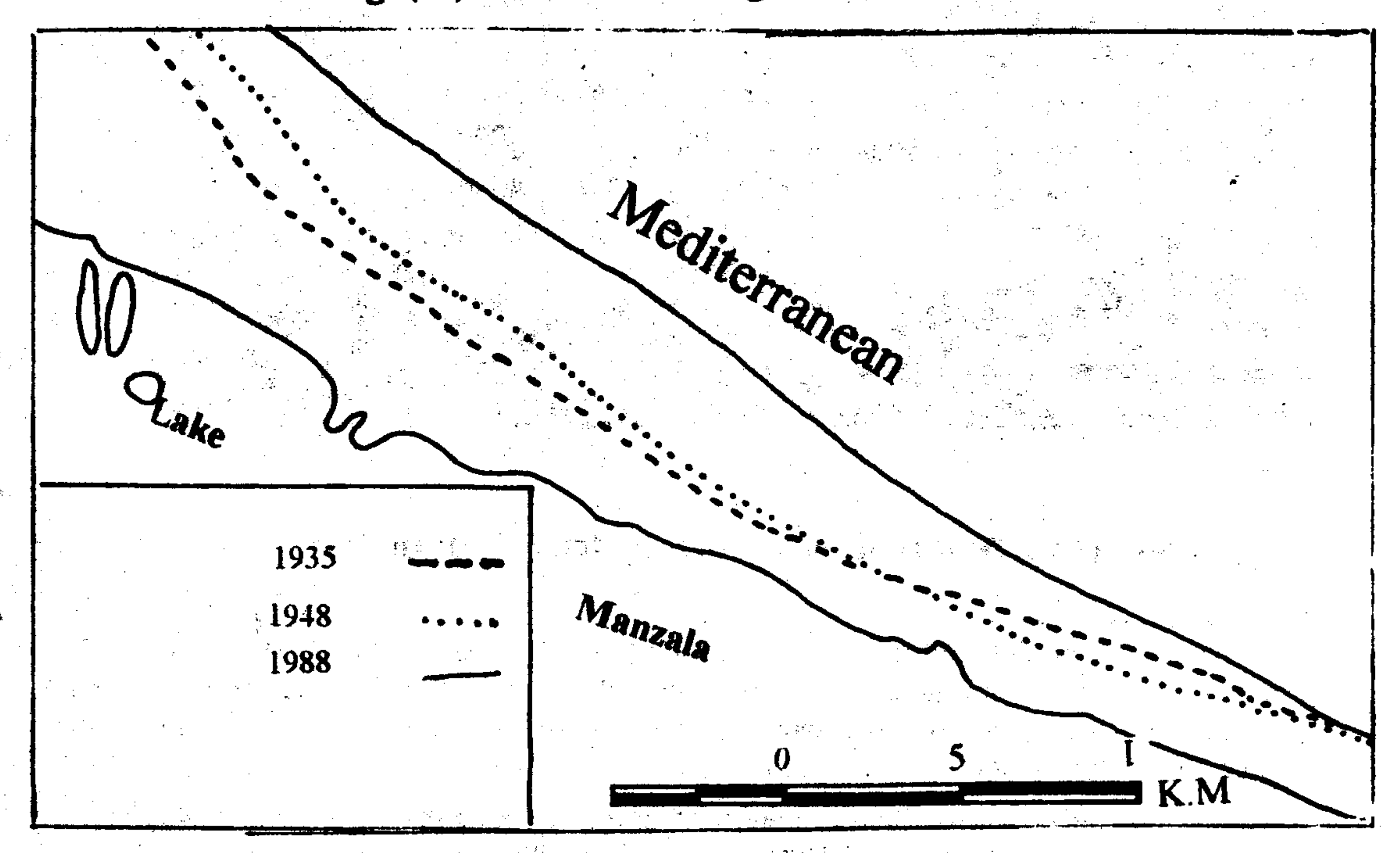



**Fig. (21): Caostal changes at Deeba-West of Ashtoum El Gamil.**

Figure (21) indicates to the shore line changes along the Deeba coast from 1935 to 1947 and from the later year to 1988.

The shore line retreating is due to marine erosion, the reduction of sediments inducing from Damietta branch mouth within the longshore currents as a result of High Dam construction* (which up set the balance between accretion and erosion) and due to the sea level rise**.

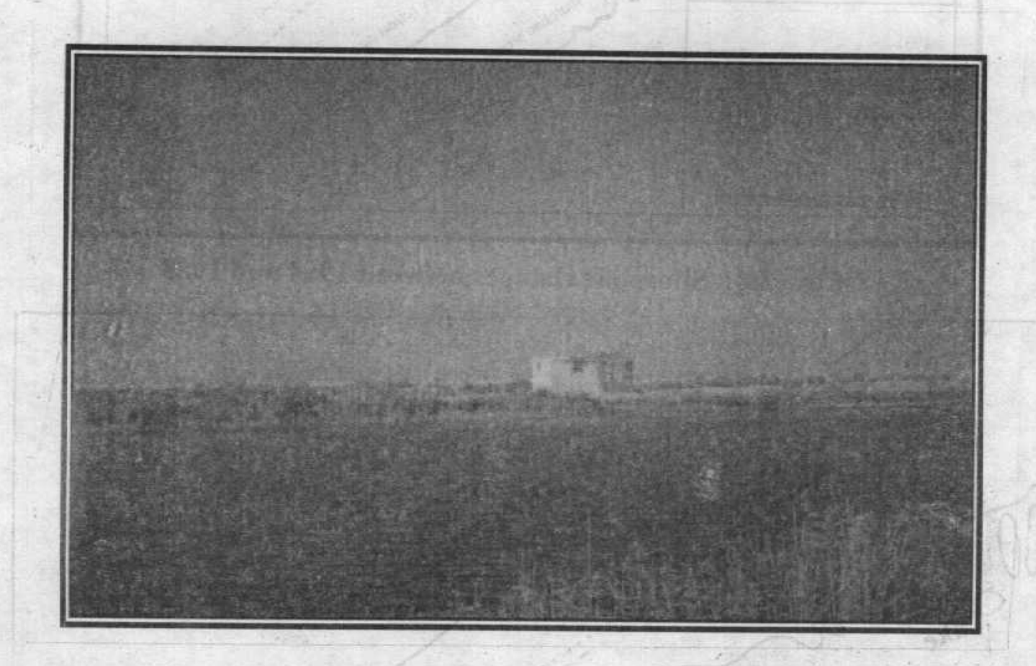


**Figure (22): A part of the north west triangle of the barrier**

* In absence of the Nile sediments after the High Dam construction 1970, The Deltaic shore as whole became severely under nourished, since then the geomorphic processes reshaped the coast causing erosion in some places and accretion in others. (Fanos, A. et al., 1989, p. 5).

** The sum of the local estimates and the global estimates shows that the expected rise in the mean sea level over 1970 level to 2100 will be 182.2 - 254.4 cm at Alexandria and 173 - 245 cm at Port Said (Fishawi N and Fanos, 1989)

## The Sites of Accretion :

The accretion and shoreline advance occurs in the following sites:

- **The site east of El Burg-village between El Karaka and El Halq:** The shore line in this site has advanced sea ward about 3 kilometers between 1912 and 1983 *(Abu Radi, F, 1988, p. 38)*. The accretion along the shore line due to the long shore currents which distribute the sediments along the for shore east of Damietta Promontory in depths ranging between 10 - 20 Meters *(Fanos, A.M., 1980)*. (Figure 20).

- **The site 2.5 kilometer west of Deeba (Diba) village :** The shore line here has advanced about 25 meters during the period 1947 - 1988. The annual rate of advancing in that period is less than 60 centimeters (6 meters).

- **The coastal area west of Boughaz Ashtoum El Gamil :** (F. 21) indicates that the shore line has advanced about 500 meters between 1935 and 1988, with annual rate about 10 meters. The advance of the shore line in this site decreases systematically east ward (Fig. 21).

- **The Boughaz area and the beaches west of Port Said :** (Figure 23) indicates to the development of the barrier in Boughaz Ashtoum El Gamil (inlet) and the western coast of Port Said. This coast which extends east south east has advanced sea ward about 3 kilometers since 1860 and there is now a broad road runing along it, out side which is a sandy beach about 250 meters wide *(British Admirality, 1976, p. 117)*.

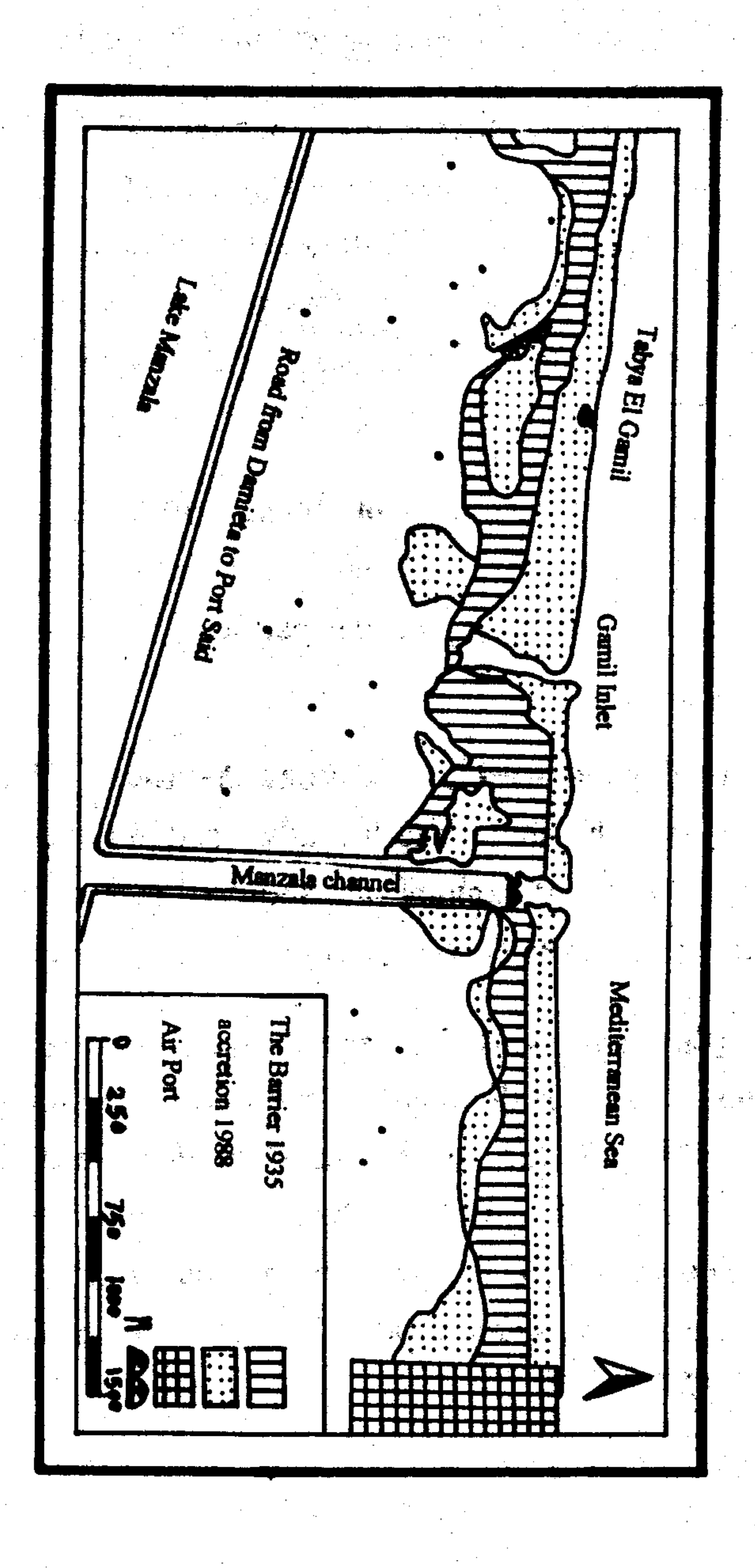



**Fig. (23): The development of Ashtoum El Gamil Coast**

## The Southern shore line of the barrier :

The southern shores of the main barrier are in the same meaning, the northern shores of Lake Manzala.

It is characterized by the following geomorphic characteristics:

- The shore line is indented by several sandy, silty bays and fronted by salt marshes for nearly the whole of its extent.
- The shore line extends irregularly south eastward more than 120 kilometers from channel soufara to the southern opening of Ashtowm el Gamil inlet (Boughaz) as seen in (Figure). The sinuosity ratio of the southern shoreline is more than two. It is so pronounced that during the high tide in the lake, the southern low flat parts of the barrier become submerged areas, particularly in the vicinity of Deeba site (Figure 24).
- The shore is fronted by numerous elongated sandy bars* - islets - separated from the shore line by salt shallow marshes premnantly liable to inundation by the waters of Lake Manzala.
- Figure (21) indicates to the advance of shoreline south ward (Lake Manzala side) as the filling up has taken place by silting and trapping sediments by the grasses and fresh water plant namely water Hyacinth in addition to the artificial aggradation *(Zaghloul and Younes, 2002)*.
- The southern coast of Deeba site has advanced south ward about 600 meters between 1947 and 1988 wtih annual rate of more than 11

* Many of the sandy bars (islands) covered by grasses are growing in size and most of them were joined with each other to form elongated large islands (Zagloul and Younis, 2002).

** Salt marshes are represented by small shallow areas at the north western part of the shore line. Salt is extracted from these marshes.

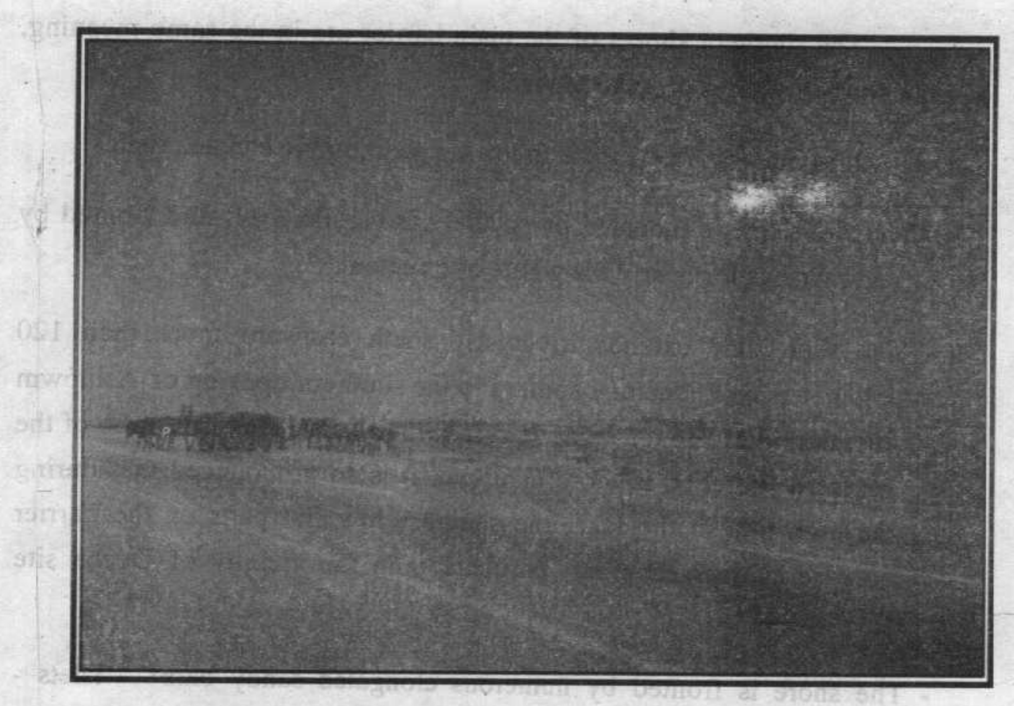


Figure (24) Sandy small is let (bar) near
The southern shore of the barrier.

meters. The advance of the shore line in this profile has laken place due to the filling up of salt marshes artificially (Figure 21).

## The Boughaz (Tidal Inlets) :

The Boughaz (tidal inlets) are narrow passages connect the Lake Manzala water with the Mediterranean sea through the barrier.

Ashtoum el Gamil inlet* (El Gamil entrance) 31° 17` long is the biggest one, situated along the mouth of the ancient deltaic degrated branch namely Tanitic**.

It extends 10 kilometers west of Port Said, 175 meters width, with an average depth of 0.7 meter and maximum deph reaches 3 meters (Figure 23).

Tidal streams have been observed in the enterance channel, the ingoing stream flows along the coast from west and enters Lake Manzala obliquely. The out-going stream issues at a great rate after high tide and carries with it quantities of sediments (British Admirality, 1976, p. 117).

### The geomorphic characteristics of El Gamil Inlet :

Ashtoum El Gamil inlet (boughaz) is located nearly concid with the mouth of degrated Tanitic branch.

Ashtoum El Gamil Boughaz consists of two inlets, the eastern inlet 220 meters wide and 500 meter in length. The western inlet namely el Tenah, lies one kilometer west of the first.

---

* There are some other inlets - passages - for example Ashtoum El Deeba (Diba) artificially blocked since more than 150 years ago.

** A recent studies in Manzala region revealed the location of four major Holocene deltaic lobes related to former distributary branches of Nile: Mendesian, Pelusious, Tanitic and Pre-Modern Daminetta, (Frihay, et al., 1988).

The two inlets are connected with each other by two bridges were constructed to provide facilities for the communication along the road between Damietta and Port Said.

The eastern inlet is the most important one; it connects permanently the Lake with the sea.

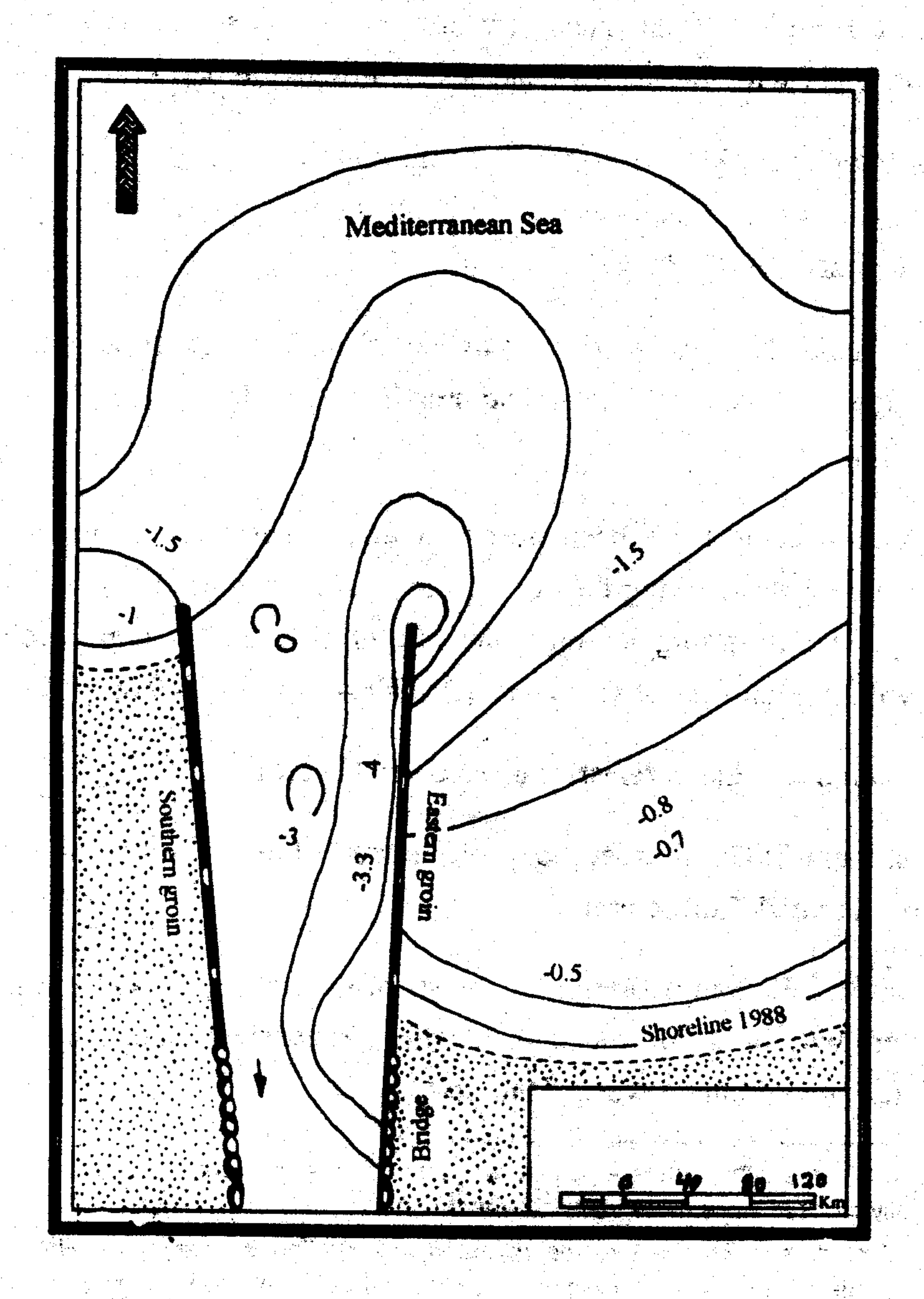



**Fig. (25): The north enterance of Ashtoum El Gamil Inlet**

Figure (25) indicates the morphology of the northern opening - sea side - of the eastern inlet and groins on both sides*.

The western side of the inlet is moderately slope toward depths not more than 3 meteres, backed with flat very shallow marshes extend west ward above the lowlying surface of the barrier and in some localities connect with the shallow marshey shores of Lake Manzala south ward.

The eastern side of the inlet slopes steeply toward the floor. This side is subjected to severe erosion and under-mining - under cutting - by the tidal current which flow through the inlet from the Lake to the sea with velocity ranging between 50 and 125 centimeters per a second, causing in the same time clearing up the floor from accumulated deposits particularly in the vicinity of the southern opening facing Lake Manzala, with maximum depth more than 4 meters (Figure 26).

The southern extension of the inlet is deeper than the northern marine opening (2 meters in depth). The later opening is premnantly subjected to accretion as the waves and currents continue to move sediment along shore** resulting in forming submarine bars appear in the extremity of the northern enterance as a sandy lowlying islets tend to move and change their directions. In some other areas along the coastline west and east of the northern opening - enterance - of the inlet, where accretion and erosion alternate, bars appear irregularly. A sandy curved spit appears occasionally connected with the extremity of the western side of the inlet as a result of long shore drift***.

---

* Owing to the severe erosion in both sides of the sea side opening of the eastern inlet, it was necessary to construct groins to protect the shore line from under mining and retreating induced by marine active processes in these sites.

** These sandy islets usually appear in convergence point (sites) between the longshore drift and the tidal current which flows from the lake toward the sea. Therefor the inlet suffers from a serious siltation problem resulting from the longshore and cross-shore sediment transport.

*** This spit are preventing the complete exchange the water between Lake and the sea. The spit and other shoals removing will activate the exchanges of water.

## Human activity in the coastal strip :

The humand activity with short term objectives frequently leads to longer term problems if it is not carefully planned, for example humans have tended to extract salts of the marshes, build their villages after removing the sand dunes or after drying sabakha and shallow swamps, It is the activities and influnces are still progressing in this area (barrier and near bars) resulting in an accelerating concentration of assets, the Hazards of shoreline retreating and inundation are growing. The major causes of shoreline erosion along the sea side of the barrier are shore line engineering structures and mining of sand from beaches and dunes, in addition of building the High dam of Aswan since 1970 which prevent the Nile sediments (the main source of beach sand) along the shore line, in absence of the Nile sediments the shore become severely under nourishe and balance between erosion and accretion became upset.

Recently, shore line management policies have considered controlling hard stabilization structures such as the sea wall 4.5 km long which extends from the east side of the Ashtoum El Gamil inlet to a groin west of Port Said city (figure 26). Sea wall protects the beaches against the marine erosion* particularly during extreme events.

Manzala canals connects Gheit el-Nasara east of Matariya and Port Said. The canal which is 34 meters wide with depths from 1.2-1.5 meter is maintained by dredging and is marked by iron and wood piles, it can be used by vessels up to 35 m long, 7 m beam and a maximum draught of 1.2m.

To avoid the side affects of the enginnering constructions, they should be closely regulated or prohibited together along the Deltaic coast as a whole.

Closer monitoring of beach dynamics, including beach profiling and beach volume - change studies must be adopted.

---

* Shore line along the sea side is generally uncontrolled and often the cost of saving almost erosion - threatened buildings is much more than the building are worth.

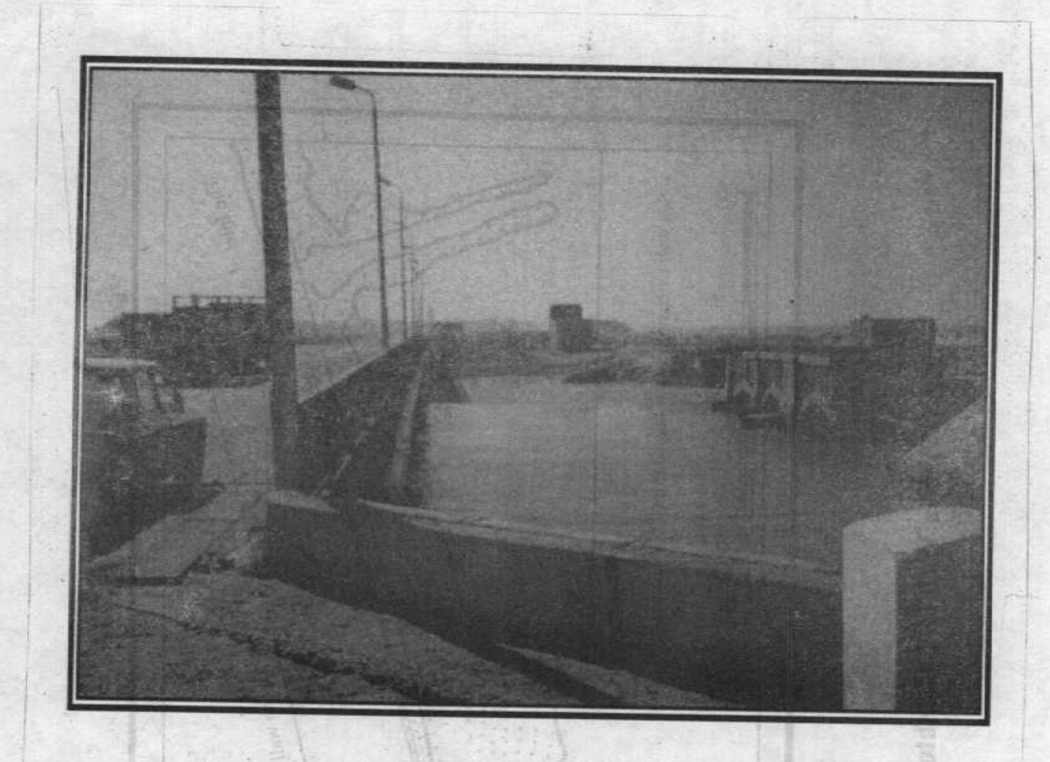


Figure (26) Ashtoum el Gamil Bridge .

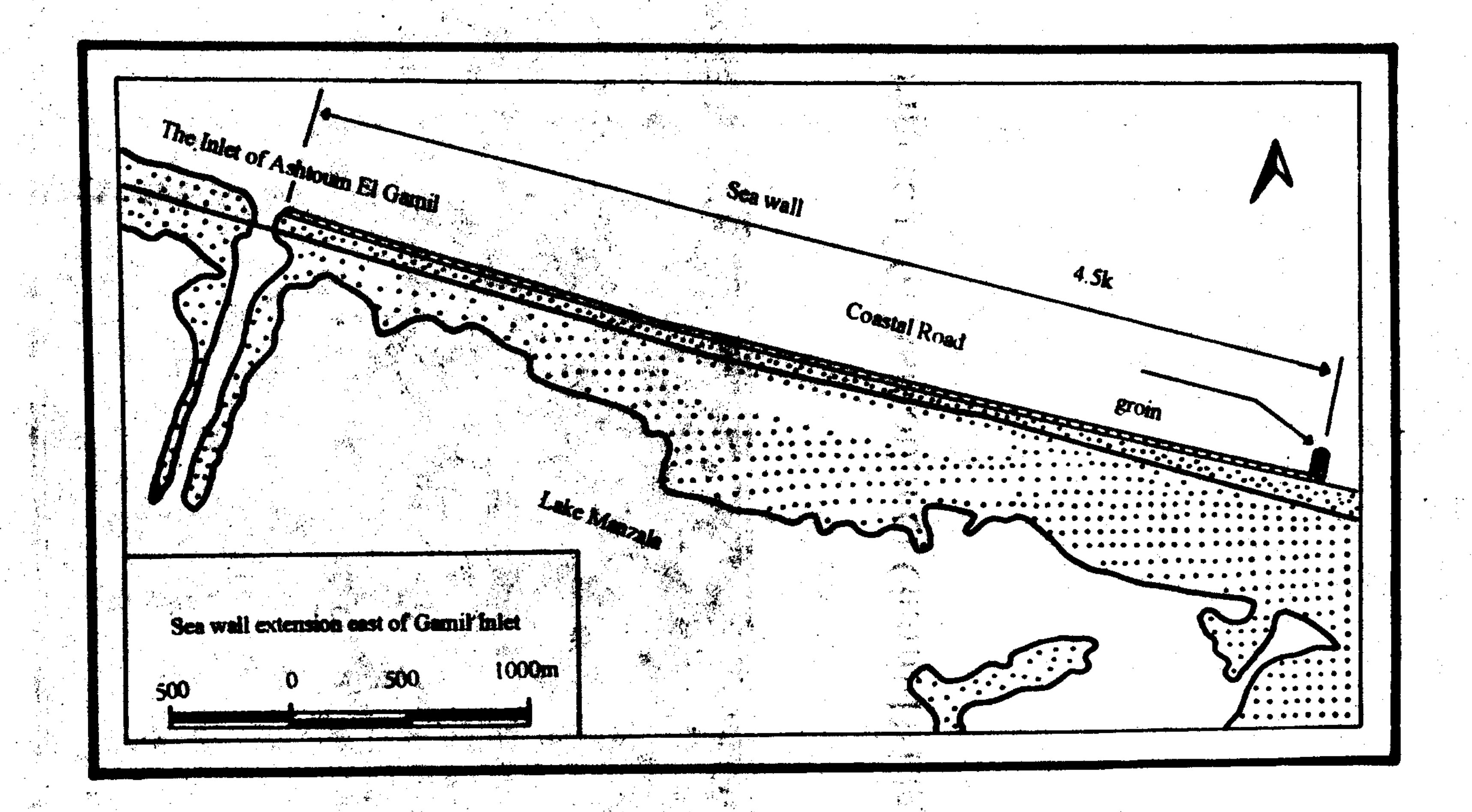



Fig. (27): Sea Wall east of Ashtoum El Gamil Inlet

# References :

1. Abu Al Izz, M.S. (1971): Land forms of Egypt. The American University, Cairo.

2. Abu Radi, F. (1988): Dynamics of coastal erosion and the recent deltaic coastal changes, in Arabic, Faculty of Arts Tanta University.

3. Academy of Scientific Research and Technology (1980): The critical problems of erosion and accretion along the Deltaic coast, unpublished research, pp. 1-4, Cairo.

4. Bird, E.C.F. (1978): Coasts "An introduction to Geomorphology, 4th ed., London.

5. El Gindy, A., Abozed, A and Farag, E (1984): Circulation pattern beyond the breaker zone along the Nile Delta coast during winter, internal report, Coastal Research. Institute, Alexandria, p. 9.

6. Fanos A. M. (1986): Statistical analysis of long shore currents data along the Nile Delta coast, Water Sci. J. Cairo.

7. Fanos, A. M., Khafagy, Sharaf El Din, S (1989): Coastal changes along the Egypitian Mediterranean sea, Water Research Center, Coastal Research Institute, Alexandria.

8. Frihy, O., El Fishawy and El Askary (1988): Geomorphological features of the Nile Delta Coastal plain, Coastal Research Institute, Alexandria.

9. Khafagy, A and Manohar, M (1979): Coastal protection of littoral drift at Ras El Barr using fluorrescent tracer.

10. Mahsoub, M.S (1994): Coasts of Egypt - Researches in Geomorphology - in Arabic, Cairo.

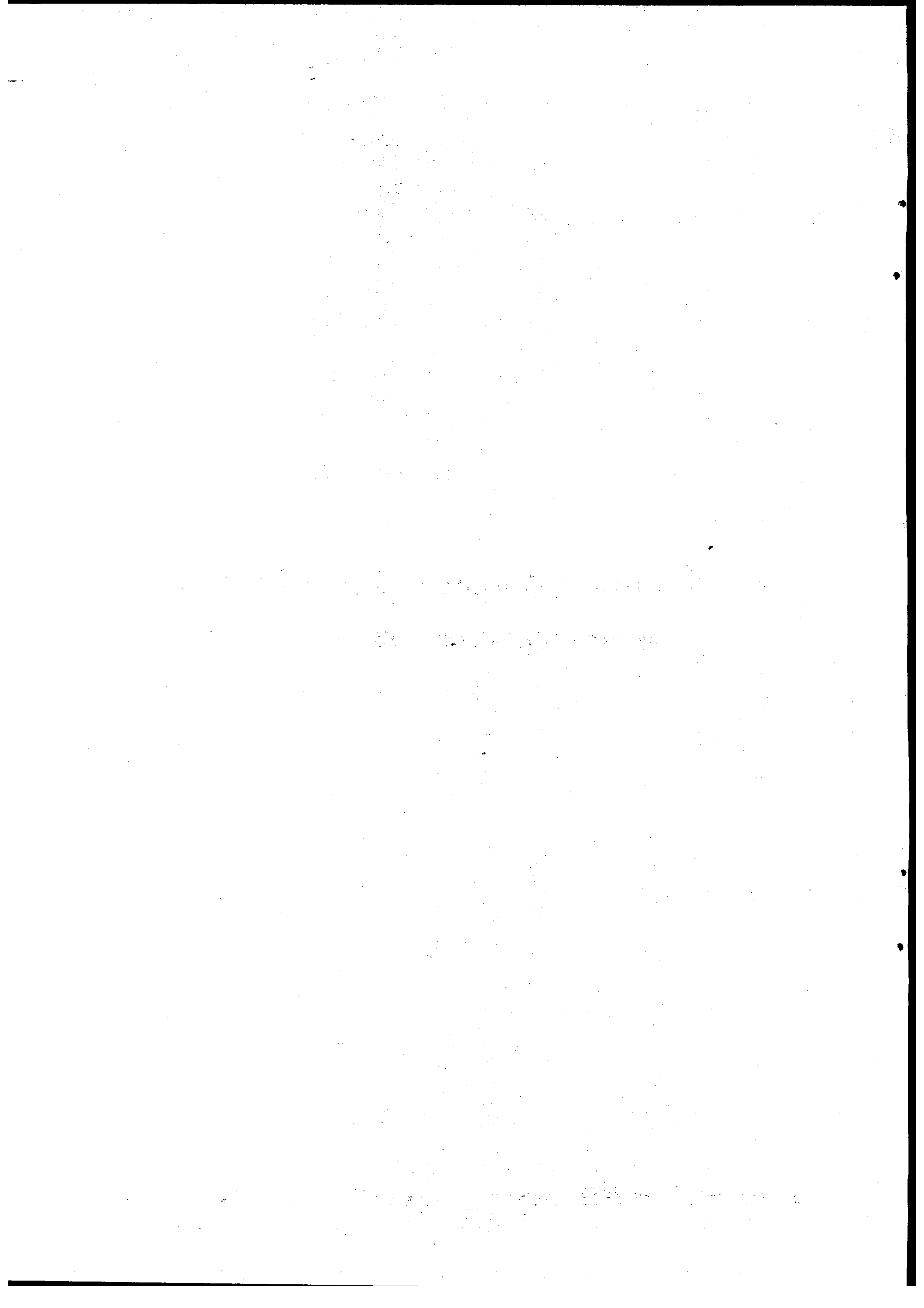
11. Manohar, M. (1981): Coastal processes at the Nile Delta coast, Shore and Beaches, 47, pp. 8-15.

12. Said, R. (1958): Remarks on the geomorphology of the Deltaic Coastal plain between Rossetta and Port Said, Bull, Soc., Geog., Egypte, XXXI, pp. 115-126.

13. Tetra Tech (1984): Shore protection master plan for the Nile Delt Coast, Ministry of irrigation, A.R.E and UNDP - UNESCO, Alexandria.

14. Zaghloul, and Younes (2002): Geomorphic Features and Pollution in Lake Manzala, Bull De La Soc., De Geogr D'Egypt, Cairo.

# The Geomorphology of Ras El Dhabaa on the Mediterranean Sea Coast of Egypt



# Introduction

Ras El Dhabaa Area is situated as a coastal strip, 170 kelometers west of Alexandria, between Latitudes 31° - 6° to 30° 48` North and longitudes 28° 12` to 28° 30` East.

It is a coastal strip, stretches from Mersa Abu Samra and Shaloufa range in the west to the eastern Dhabaa bay and Alam Darb El Naar range in the east for a distance of more than 27 kilometers, extends from shorline in the north to contour line 60 meters above sea level in the south with total area of 255 square kilometers (Figure 28).

Ras El Dhabaa area is characterized by its sandy flat indented coastline, bays backed with marshes, very shallow lagoons, impeded low sandy ridges and dunes, except in the case of Abu Samra low active cliffs in addition to cliffs of Sirra coast.

The coastal plain consists of distinctive ridges of calcareous rocks-oolitic lime stone - depression backed by plains that rise gradually toward the southern tableland.

This study aims at revealing the significant characteristics of the area and the human impact affects the natural environment.

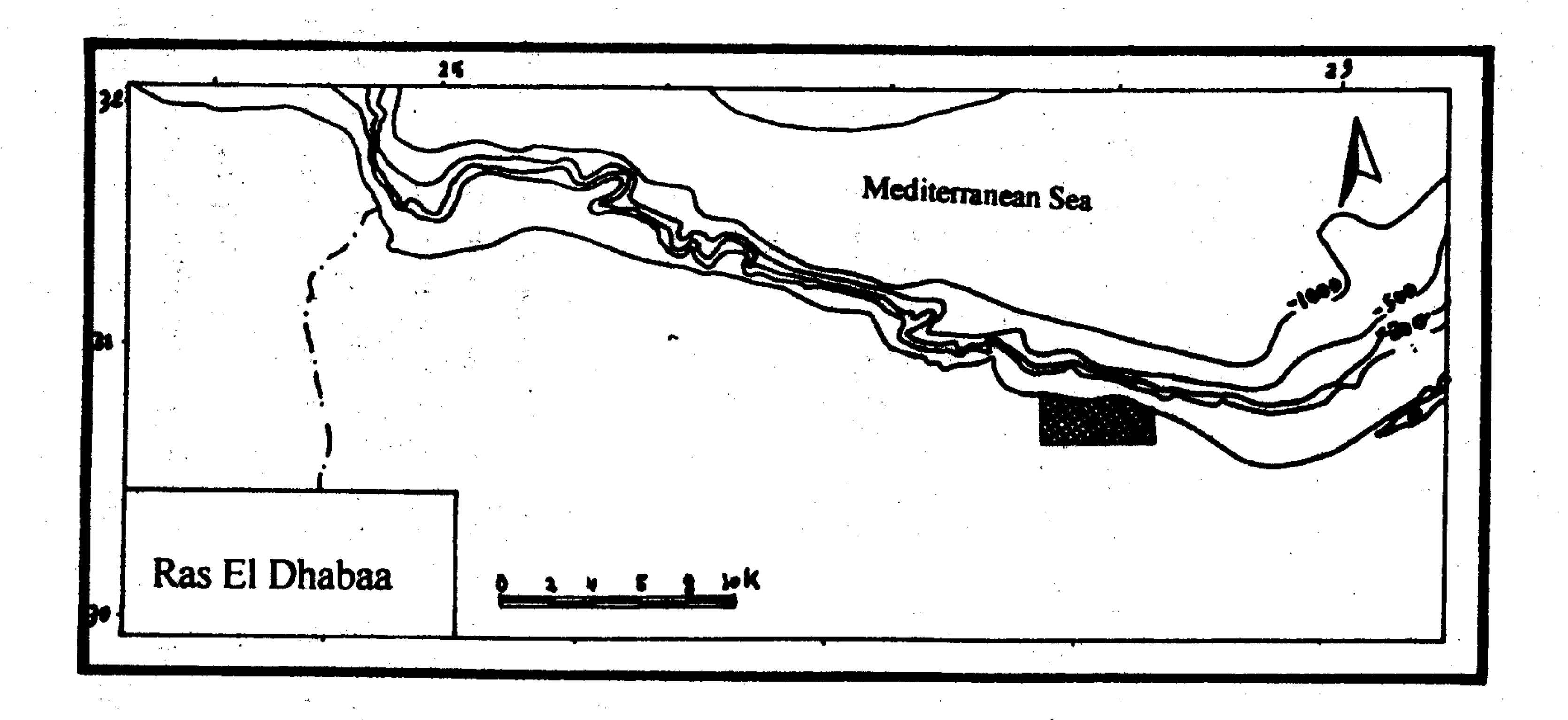



**Fig. (28): Ras El Dabaa**

## Geology of Ras El Dhabaa Area:

The rock succession in Ras El Dhabaa area ranges - in age - from tertiary to Recent (Figure 29).

Table (2) shows the main formations in the studied area with a geological section.

**Table (2): The geological formation in Ras El Dhabaa area.**

| The thickness of the geological section (in meter) | The thickness of the geological section (in meter) | Age |
|---|---|---|
| Variated | - Beach sands. | Holocene |
| Variated | - Dunes deposits and accumulated sands | |
| Variated | | |
| Variated | - Calcareous crusts. | |
| 12 | - Fluvial deposits. | |
| 50 | Oolitic limestone. | Pleistocene |
| 3 | Limestone. | |
| 38 | Lime stone. | Pliocene |
| 120 | Chalk lime stone | Miocene |
| 26 | Marl limestone | |
| 14 | Mud and Marl. | |

## 1. Miocene Succession :

The Miocene rocks exposed in some localities in the study area are represented by chalk limestone and marl, they reach more than 125 meters thick in Abu Samra drainage basin as seen in (figure 29).

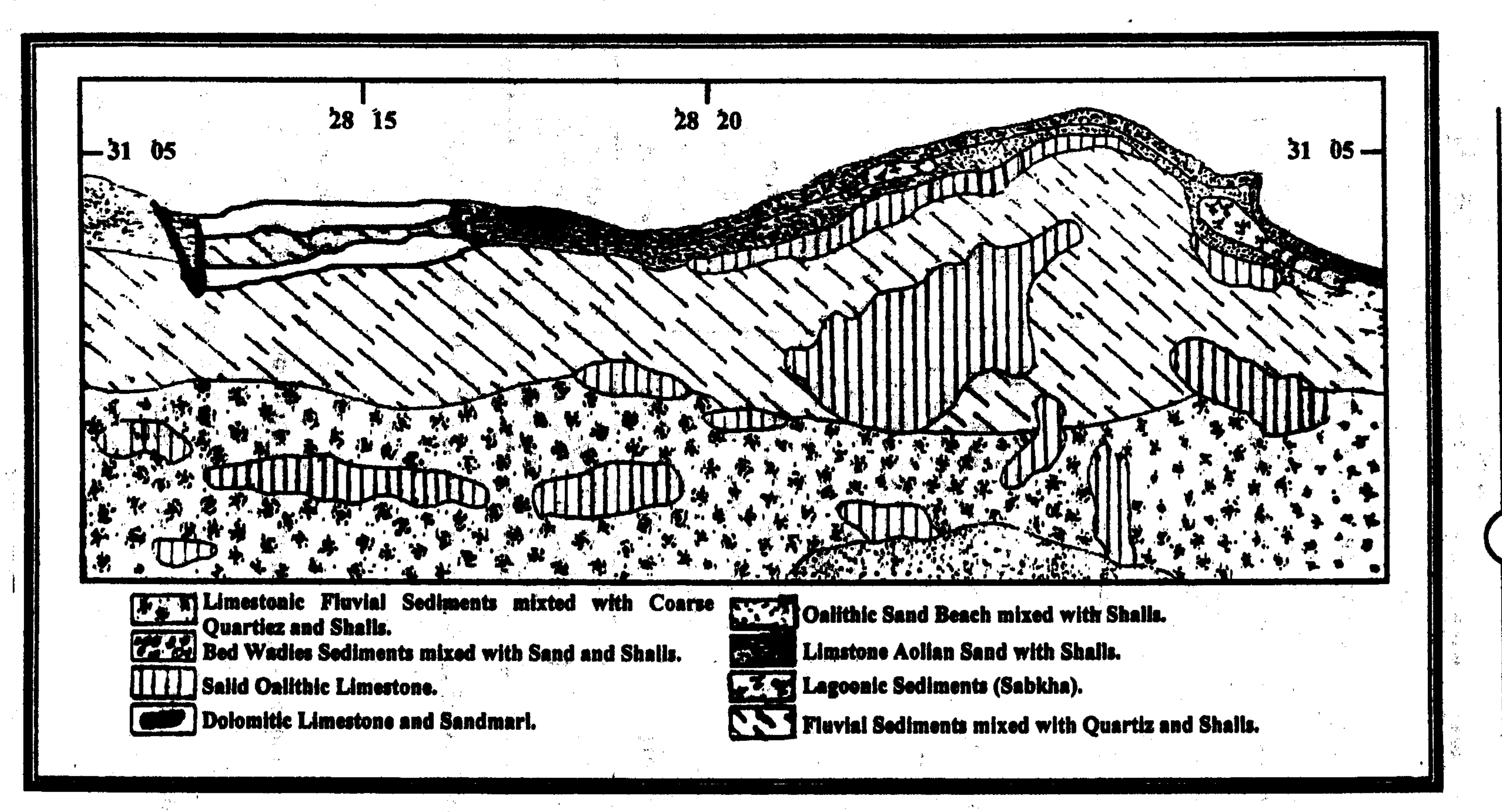



Fig. (29): The lithology of El Dhabaa Area.

The formations are classified to two units:

* **The upper unit :** The formation of this unit is represented by white chalk limestone and dolomitic limestone with thickness of 16 meters, it may caped by solid duricrust owing to recrystalization processes.

* **The lower unit :** Consists of sandy yellowish marl, mixed with ferogenous red laminae. it occurs in the rocky cliffs of Abu Samra area with thickness of about 8 meters.

## 2. Pliocene formation:

It is overlain by younger pleistocen formation, consists of calcareous rocks, highly fossiliferous. It attains a thickness of about 38 meters.

## 3. Pleistocene and Recent formation:

These formations are composed of whitish oolitic sands cemented by calcium carbonate.

Oolitic sands are represented in oolitic sand dunes - ooliti ridges which extend parallel and subparallel the present shore line.

* **The Recent deposits**: These deposits are represented mainly in the alluvial deposits covers the floors of the dry valleyes with 12 m thick, aeolian accumulated sands, marshey deposits and beach sands.

The recent deposits occur as a thin veneer covering the older formation in various parts along the study area.

## Structure :

The geoglogical structure of Ras El Dhabaa area are discribed by Shata 1957, El Shazly 1964, El Shamy 1968 and Abdel Salam and El Wan 1972.

The area of Ras El Dhabaa is locally affected by some structural undulations, these are represented by two monoclines oriented north/east - east - south west (Abu Samra - El Sira) with a local basin in between.

The coast is highly influenced by NNW-SSE, NE-SW, NW, NW-SE and ENE-WSW lineaments as well as by some fold trace as mentioned above. This is manifisted by the convex shape of El Dhabaa ***(Maged, L., et al., 1991, p. 14).****

---

* Linear topographic features, sanddune a lignments, lagoons shorelines and linear drainage wadis often reflect joints and fractures.

## The Geomorphological Characteristics of Ras El Dhabaa Area:

The area is identified - a geomorphological point of view - into two significant geomorphic units.

**1. The Northern Low Coast :**

It can be divided into following (figure 30).

- The shoreline with related features such as coastal low lying cliffs, sandy beaches, very sallow lagoons and bays.
- The fore shore sandy dunes and the lagoonal depressions.

**2. The Elevated Coastal Plain :**

Includes the coastal oolitic sand ridges, small drainge basins, sand sheets and inland elongated depressions.

The main geomorphic significiances of the two units can be summerized as follow:

## The Northern low coast :

### The shore line:

It extends as a low sandy beaches and low lying rocky active cliffs for a distance of 40 km from east to west - convex in configuration - with sinuosity ratios about (1.3).

***It is characterized by the following characteristics:***

It stretches from west to east as slight promontory for 40 kilmeter. it can be divided into two distenctive sections, the first section extends from longitude 28° 20` east ward and the second one extends from 28° 20` longitude west ward (Fig. 30).

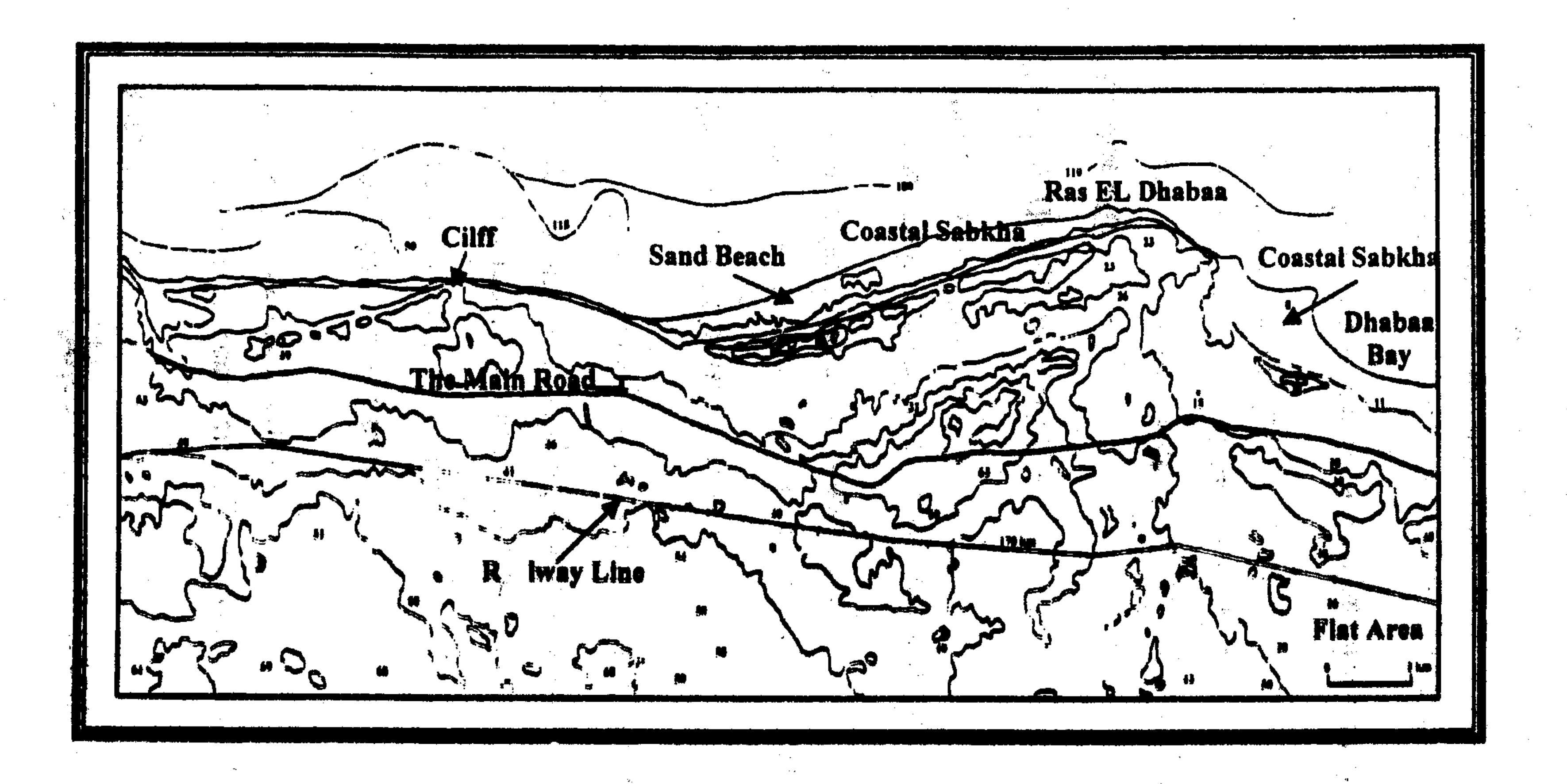



Fig. (30): Contour map of Ras el Dhabaa Area

The eastern section of the shoreline is more sinusus than the western section, it consists of low lying broad sandy beaches, marshes, shallow longoons and small two bays facing east word, fronted by shallow littoral waters and backed by sandy beaches.

The eastern extension is a rocky cliff coast fronted by gently sloping platform without a significant topographic break* extending from the base of a cliff to the nearshore sea floor below low tide level with a marked drop of edge sea ward.

The low cliffs are characterized by erosional features associated with a geological weakness such as stackes, sea archs, caves and notches.

The cliffs occur in the positions where the miocene limestone scarps over look the sea as cliffs 26 m high and more than 2.5 km long**.

The shorline is fronted sea ward by extending littoral shallow water for different distances as seen in figure (30) which shows that the 5 depth line extends far from the shoreline with distance ranges between less than 500 meters offshore Abu Samra to about 1000 meters (one kilometer) east ward. The 11 depth line extends far from the shore line for a distance ranging between one kilometer to 2.5 kilometers.

Ras El Dhabaa locality - site - and Mersa El Fallah (31° 21` North and 27° 21` East) can be identified clearly by conspicuous islets and salt stacks close to north of it. A rocky shoal with depths of less than 2 meters (6 feet) over it, lies offshore east of Ras El Dhabaa and Fallah inlet.

---

* Except accumulated debris occupy the cliff foot and as steeper than the rest of platform.

** Mersa Abu Suma lies 3.5 km east of Ras Abu Girab, has depths of less than 2 meters and is nearly connected to the mainland south west by a spit with a depth 5.5 m over it (British Admirality 1976, p. 101).

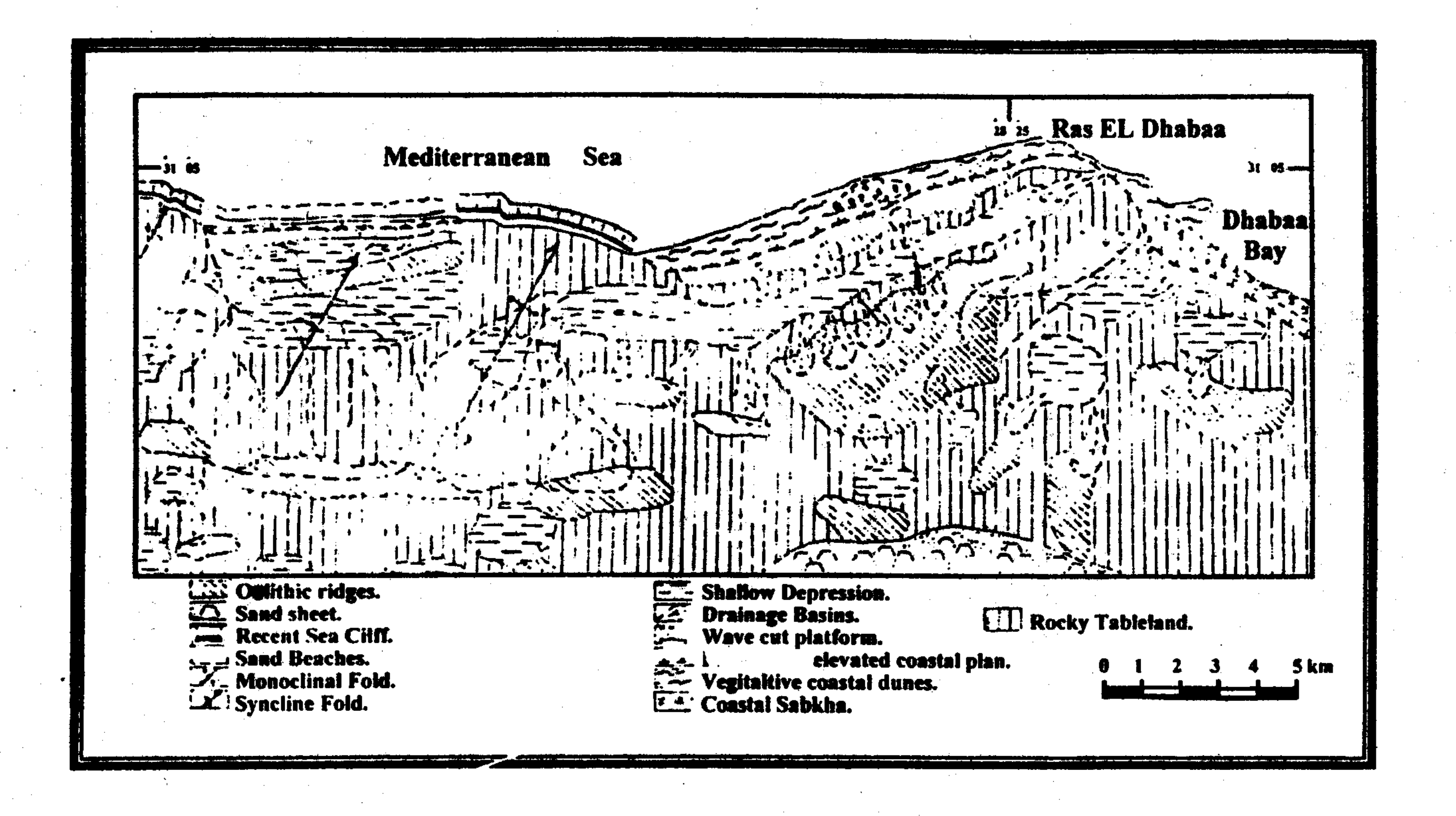



Fig. (31): Morphology of Ras El Dhabaa Area

**The Geomorphology of the coastal cliff :**

A line of conspicous remarkable black cliffs, extend along the shoreline of Sira coast and close to Mersa Abu Samra with height reaches 26 meters above sea level.

(Figure 32) indicates to the geomorphic aspects of rocky cliffs of Abu Samra coast which can be summerized as follow:

- The rocky cliff of Abu Samra coast is 26 meters in height, it slopes sea ward uprubtly (Figure 32). The cliffs consists of the upper steep slope (free face) 45°, influenced intensevely by joints and fractures and the lower boulder slope or boulder terrace which is composed mainly of gravel and boulders* produced as a result of wave erosion at the base of a cliff - under mining - and rock, debris sliding processes
- This boulder terrace is steeper than the rest of the fronted platform, has slope ranges between 20° - 30°. this feature is a distinct morphological element in this type of rocky coasts (Figure 32).
- A narrow platform extends as a wave cut flat bed rock slope slightly sea ward. The platform consists of double level, the older one extends imediately close to the boulder terrace. The recent low surface extends sea ward as abrasion rocky low pavement cut in the marly sand stone by wave erosion and wave quarrying. It has a marked drop at its sea ward edge.
- The diagramatic profile (Figure 32) indicates to a minor notch cut above boulder terrace*. It is restricted to the intertidal zone.

---

* Notches cut in cliffs composed of calcareous rock. Their geometry is an integration of either chemical erosion - solution, wave action including abrasion, biological erosion boring by marine organisms or a combination of these.

Emery and Foster 1956 believed that the notch had been formed by the wave induced, removal of grains loosened by weathering possibly solution and hydration (Sunamura, 1992, p. 186).

- The littoral waters less than 18 meters below sea level extend a distance of 2.5 kilometers from the drop plunging edge of submerged wave cut platform loward the open sea (offshore).

- The sandy beaches disappear in front of the cliff base due to the active high energy waves arriving the rocky cliff coast. The occurence of these waves depends on relative magnitude of breaking depth of incoming waves and the water depth in front of the cliff (Sunamura, Ibid, p. 28).

## Sandy beaches:

The sandy low beaches occur along Dhabaa coast in two positions. The first position extends east of Ras El Dhabaa and the se[illegible]nd one extends for a distance of 6 kilometers from the western end of [illegible] rocky cliff coast of Sira site to the end of Abu Samra cliffs.

The beaches are ranging in width between 500 meter to more than 1.5 km. This beaches along the shoreline are mainly made up of loose deposits of oolitic sands which eroded from the oolitic limestone ridges striking the shore in that areas.

The grain size of variation of the beach sands along the shore shows fluctuations of both medium sand and finer one, the courser sand is present in the back shore of the beaches.

The sands of the beaches are mixed with little amounts of shell fragments and heavy minerals and silt. The increases abundance of coars

The southern ridges are intermitted and present in the form of alternation with longitudinal shallow depressions. The main southern ridges from west to east, shaloufa ridge which ranges in height between 50 m to 76 m., Halima ridge (50-79 m in hight) and Alam Darb El Nar ridge (35 m) (Figure 35).

**The shallow depressions :**

The depressions occuring between the deposits mainly representing the weathering products of the calcareous dunes and limestone plateau (Tableland). wherever close to the sea level, the soil suffers from high salinization.

The soil moisteur retention is about 20% and are moderately well drained, with depths less than 90 centimeter **(Abdel Salam, M and *Elwan, 1972, p. 79)*******. The natural vegitation is scanty and plant associations distributed in the various parts of the areas are namely Ammophila arenaria, thymelea hirsuta, salicorreto suadetus. etc.

## Drainage lines :

The western part of Ras El Dhabaa area is cut by a number of south/east - north/west valleys. The most common pattern formed by drainage lines (ravines) is the modified dendritic pattern with shallow, relative wide courses.

The drinage pattern in the north - western part of the area is intermittent with few tributaries.

---

* More than 97% of the total area of the elevated plain is ranging in height between 10 and 50 meters.

sands in winter and the finer once in summer may be related to the fact that the beach recieve energy in winter than in summer months.

At some stretches the beach is covered by pebbles and gravels.

The mean grain size diameter within the beach along the coast tend to decrease gradually from shoreline towards the sea.

## Shallow Lagoons :

Along the low coastal plain, we can recognize a shallow elongated lagoon, situated at localities of Ras Abu garuf, Mersa El Dhabaa and west of Ras El Dhabaa.

These shallow lagoons are filled with eolian and fluvial deposits, derived from the fringing low oolitic limestone (Figure 31).

The eastern lagoon extends from north west to south east for 6 kilometers with mean width less than 500 meters. The total area of the lagoon is about 3 square kilometers, with depths ranging from 1 to 1.5 m. The lagoon is separated from the Mediterranean sea by a narrow low sandy barrier, composed essentially of unconsolidated - loose - white oolitic sand grains, its elevation is ranging between 6 and 13 meters. Figure (31) indicates that the eastern lagoon is bordered from south by low oolitic limestone ridge namely Dhabaa and by some sandy hills.

The western shallow lagoon extends from Ras El Dhabaa westward for 3 kilometers. It is a small elongated lagoon with an area of 1.5 square kilometers, and with average width about 300 m. It is less developed than the eastern lagoon. The deposits of the western lagoon floor are sandy loom, mixed with silty clay loom, it is very dark gray to black due to the high moisture content and the intensive growth of halophytic plants. the

water of the lagoon is highly saline owing to the inundation by sea water particularly during the surges wave storm (exceptional submergence). The western lagoon is backed as the eastern one by oolitic ridge namely El Tarbyia ridge* (Figure 30).

**Fore Shore Dunes and Nebbaks :**

Almost of the frontal dunes are long and narrow, having present shoreline, except at El Sira site to the west of Ras El Dhabaa, where the miocene plateau - tableland - extends to the seashore, forming steep cliffs 26 meters high.

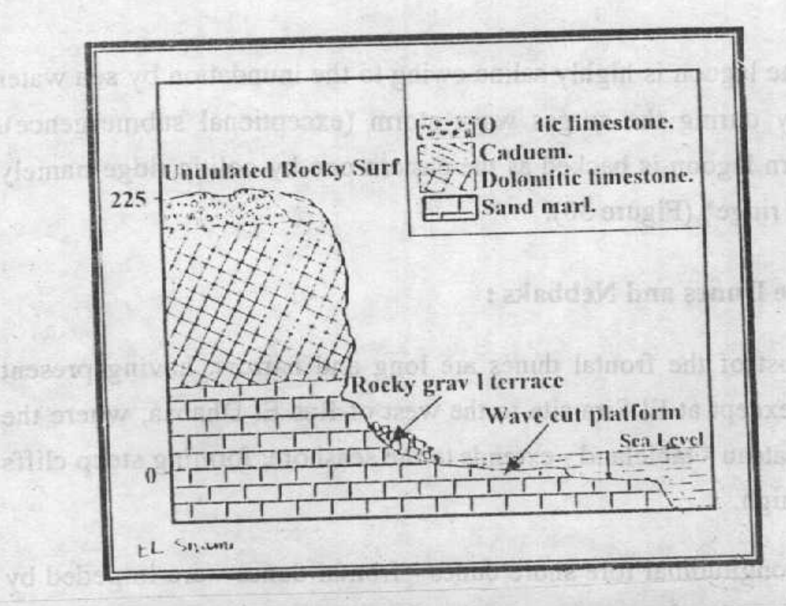
The longitudinal fore shore dunes - frontal dunes - are impeded by intensive growth of natural vegetation.** The dunes are composed of white coarse sandy loose grains of pure oolitic limestone, ranging between fine and medium size (80%). The frontal dunes are generally extend - as longitudinal low ridges of loose sands - parallel with the shore line.

Low small Nebbaks are common in the fore shore strip. Most of them vary in height between 20 meters to one meter only, these sandy forms are related with intensive growth of hydrophyic plants. almost of Nebbaks are circular in shape and some of them are oval shaped, particularly east of El Dhabaa bay (figure 33) indicates to El Dhabaa bay which backed by sandy low nebback covered with plants.

---

* This ridge is composed of calcureous aeolianites caped partly by a thin crust composed of brown silicieous limestone.

** The common plants are halophytic such as salsola, Artemisia, Haloxy lon and Suede pruinosa (Tadros, T., et al., 1967, p. 55).



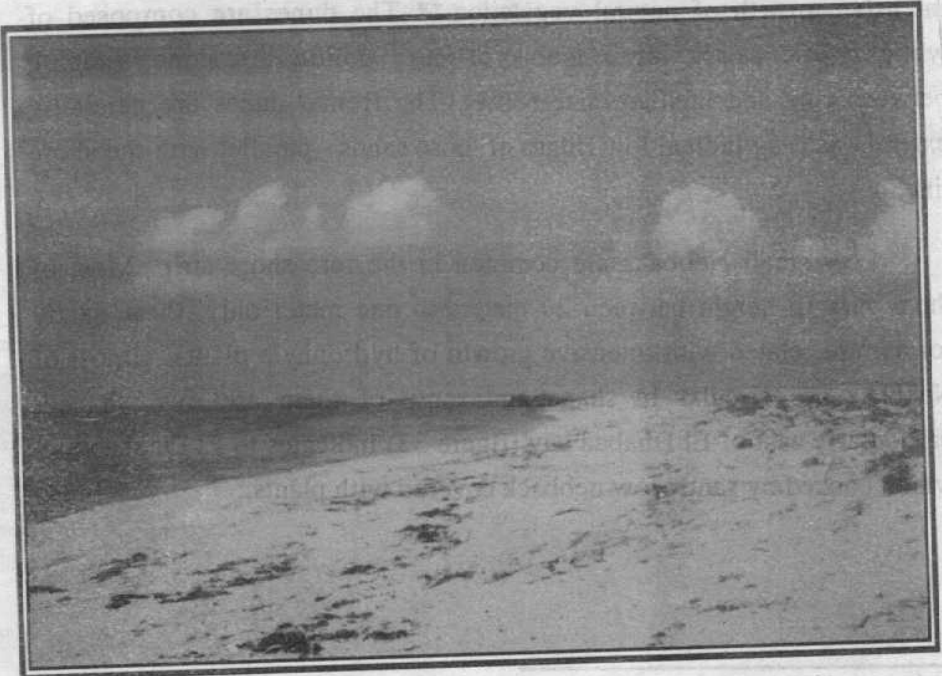



**Fig. (33): Dhabaa bay fronted by tidal shallow flat and backed by sandy beach.**

## Elevated Coastal Plain :

The elevated coastal plain represens the back shore of El Dhabaa coastal area, it occupies the largest part of the area, It extends as an elevated plain between two contour lines 10 m in the north and 6 m in the south.

The surface of the elevated coastal plain is unduluted, occupied by a series of elongate ridges subparallel to the coast rising in places south word to +50 m and alternating with shallow depressions. The area is cut by drainage lines (ravines).

### The eolongate ridges :

The northern elongate ridges are more conspicuous and more recent than the southern ridges. The northern ridges include Ratip, Tarbyia, Abu Sammra and Dhabaa. They are varying in height between 33 meters (Dhabaa ridge) and 48 m (Abu Samra ridge).

The ridges are composed of calcareous aeolianites belonging to the pleistocene and Recent times. These are capped by a solid thin brown crust composed of siliceous limestone. Originaly, the ridges represent old consolidated sandy dunes formed along a preceeing shoreline and where subjected in recent time to slight movements accompanied by some faults ***(Tadros, T. et al., 1967, p. 41)***.

The ridges extend generally from east to west with widths range between 100 meters to more than 500 meters (figure 34).

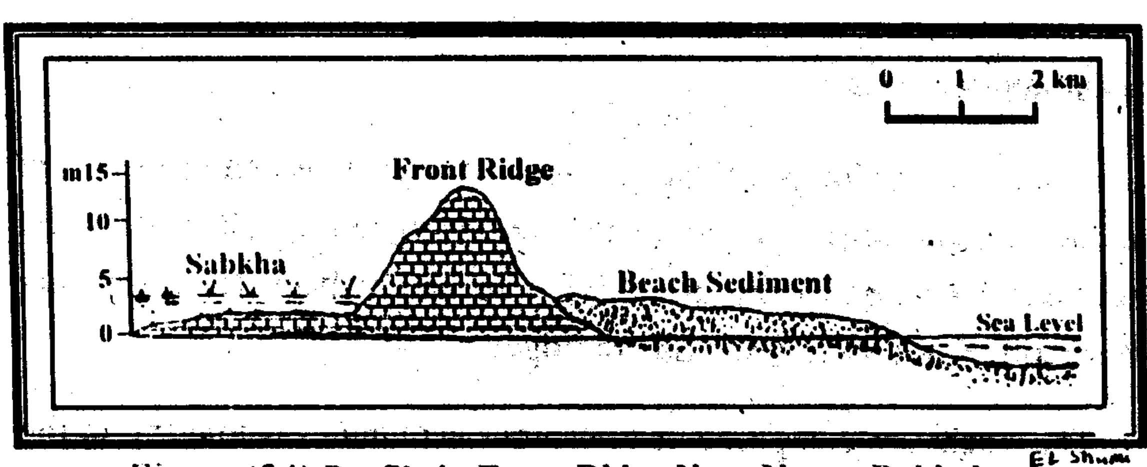



Figure (34) Profile in Front Ridge Near Nagaa Dekhel

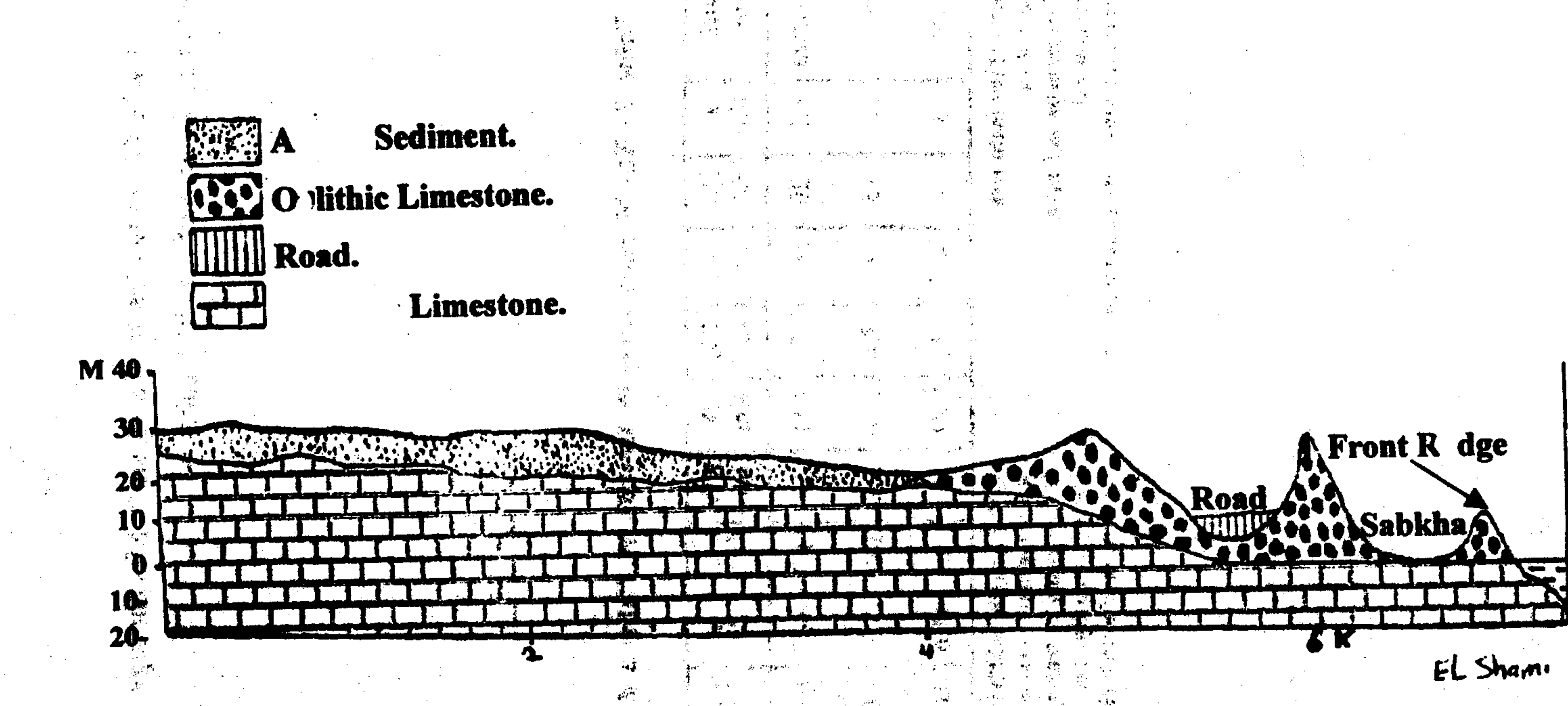



Fig. (35): Geological Relief in Dhabaa area from the shore line south ward.

Table (2) indicates to the Basin's Morphology of the three main valleys at the area of Ras El Dhaba.

**Table (3): The Morphology of W. Dhabaa, W. Gaber and W. Abu Samra.**

| Wadi name | L Km | BA Km | SL Km | BL Km | D Km | BW Km | L/W | R | RV | CR | F. Factor | L/R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abu Samra | 6.5 | 29 | 36.5 | 7 | 1.51 | 4.4 | 1.7 | 8.57 | 0.098 | 0.7 | 0.59 | 0.86 |
| Gaaber | 2 | 15 | 21 | 7.4 | 1.24 | 3.2 | 1.46 | 5.3 | 0.05 | 0.6 | 0.68 | 0.92 |
| El Dhabaa | 3 | 6 | 4.5 | 6 | 0.83 | 1 | 6 | 11.6 | 0.05 | 0.35 | 0.17 | 0.23 |

L = Length of the main valley
BA = Basin area
BL = Maximum basin length
BW = Basin width
SL = The total lenths of the streams (orders).
L/W = Length / width ratio
R = Ruggedness - value
RV = Density of drainage.
CR = Circularity ratio = BA/AC
AC = Area of a circle that is eqivalent to basin area.

Figure 36 and Table 3 indicate to the characteristics of the drainage basins of the three main vlleys in the area of Ras El Dhabaa.

These characteristics can be summerized as follow :

1. The three basins give drainage densities very low, ranging between 0.83 in Wadi Abu Samra and 1.5 in Wadi El Dhabaa, according to Horton 1945 and Strahler 196' these values indicate that the basins are affected by the high filtration capacity* of the surface deposits in addition to the colian deposition, and semarid climatic conditions.
2. The three valley (vales) are characterized by their shallow and very short courses which dissect the northern friable flattish low land in the form of sufbdendritic drainage pattern. The short, shallow ravines 2 km to 6.5 km long reflectg the lithological uniformity, initial slopes, filtration, run off capacity and degrees of erodability, the total lengths of courses within Abu Samra basin is 36.5 km decreases to 4.5 km only in El Dhab aa basin and to 21` km in W. Gaber basin (figure 36).
3. The three basins give very low huggedeness, rangeing between, 98 in W. Abu Samra basin and 0.05 in both W. El Dhabaa and W. Gaaber, these very low ruggedness indicates to the low lying surfaces of the area.
4. The drainage lines heading in the northern margins of the table land descend to the depressions floor, while the main course of Wadi Abu Samra descends a step about 25 m before entering the coastal low strip toward the sea.
5. A denderitic drainage pattern dominates the coastal area of Ras El Dhabaa. Obviously this pattern is controlled by the dip slope as main

* The soil are presently under cultivation (barely, olive and fig trees) the main sources of water in the area are either from the surface water or from the under ground water which is of rainfall origin.

trunks (coures) and primary tributaries follow north ward slopes through homogenous rocks.

6. It seems that absence of well marked drainage lines characterizing the northern coast of western desert is chiefly owing to lack of slope rather than shortage of rainfall. Well developed drainage lines are found only wherever steep slopes obtain such as those dissecting the rugged margins of Dhabaa scarp south ward the elevated coastal palin before they evetually end to a numerous alluvial fans**, or end to internal playas within the internal depressions, where the water are lost through seepage - infiltration - and evaporation.

***There are several headlands and promontories characterize the shore line west of Ras El Dhabaa.***

The significant head lands are :

## Ras El Hekma :

Ras El Hekma or Ras El Kanayes lies 230 km north west of Alexandria on Latitude 31° 15` North and longitude 27° 511 East.

It is boardered from the north and north east with Mediterranean coast which runs in nearly an L shape forming gulf of El Hekma (gulf of kanayes), Looks like nearly all the headland of the northern coast.

The northern extremity of Ras El Hekma appears as an island from a distance of about 16 Kilometers due to a remarkable gap in the land a short distance within the cap ***(Mediterranean Pilot, volume V., 1988, p. 101).***

---

* Seepage usually occurs under neath the sandy surface deposits.

** Almost of the vales have partially disappeared under the sandy deposits.

These drainage lines end by forming alluvial fans in the elevated plain floor as wadi Gaber or extend to sea (Wadi Abu Samra).

There are about 25 drainage lines extend through the area but the main drainage lines are only three. Wadi El Dhabaa, Wadi Gaber and Wadi Abu Samra.

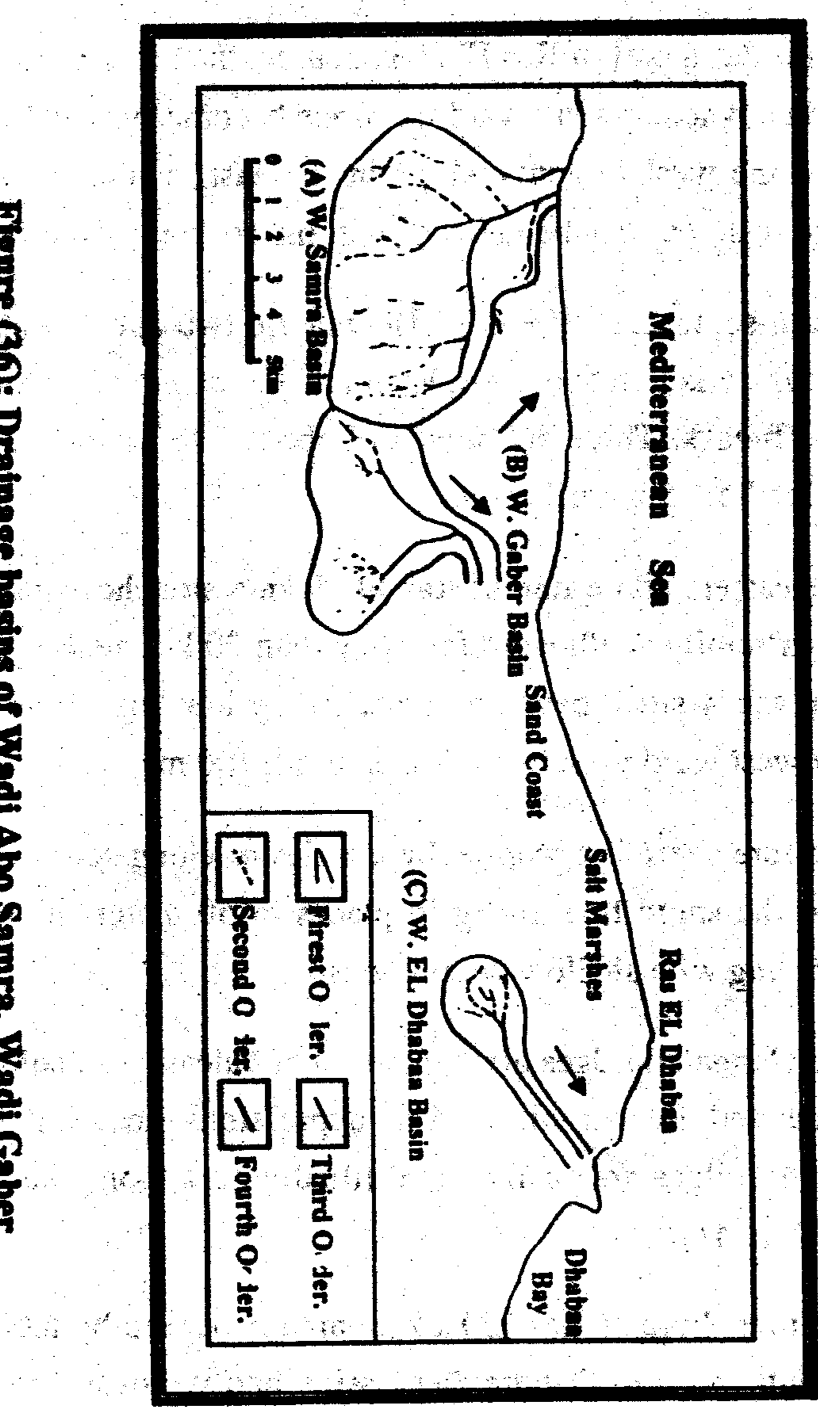



Figure (36): Drainage basins of Wadi Abo Samra, Wadi Gaber and Wadi El Dhabaa

The northern shoreline of Ras El Hekma is bordered by black rocks which show up will against the oolitic sandy hills (Figure 37). The western border of Ras El Hekma is contour 90 meters above sea level in the north and central extension, while in the south, the elevation descends to 45 meters only west of Fuka plain. indicates that the contour lines in this area take a north - South east orientation.

In northern part of Ras El Hekma area, the surface rise rapidly from east to west, whereas southward the slope becomes gradual from elevated surface in the west to gentle slope in the east toward the shorline. The difference in slopes can be noticed from the spacing of the contour lines.

South-south east of Ras El Hekma are two above water rooks, the larger of which is 5 m above sea level and the other is 3 m high, on which the waves breaks. There are depths of about 7 to 11 meters inside these rocks which lie 1.5 km off shore.

The eastern shore line of Ras El Hekma stretches sinuous from the northern extremity south ward for more than 20 kilometers; it is indented by several sandy small bays and is backed by low lying sand beaches rise gradually west ward to an elevation of about 100 m.

The fore shore is occupied by a series of elongated ridges normally parallel to the shore line, rising in places to 50 meters above sea level, and alternating with shallow depressions.

The elongated ridges are composed of calcareous aeolianites due to pleistocene and Recent times. The depressions occuring between the oolitic sandy ridges are shallow and filled with a loomy soil (Tadros, T. et al., 1960, p. 41).

The fore shore of Ras El Hekma area is backed by tableland which extends south ward to Qattara Depression and westwarid to the western

boundaries of Egypt. The tabeland (plateau) dominated by Neogene chalky marl, limstone, clay and sandstone.

The surface of Ras El hekma area is dissected by a number of gullies and short small ravines which extend west - east direction toward gulf of Ras El Kanayis following the dip-slope of the surface.

**Ras Alam El Rum :**

It is an ancient promontory lies on latitude 31° 22` North and longitude 27° 21`E.

It represents the termination of a spur 41 meters high from the apex of two ranges of oolitic sandy hills which run west and south from the extremity of the promontory.

**Abu Hashafa Headland (Ras Abu hashafa) :**

It is a bluff white headland lies on latitude 31° 12` north and longitude 27° 39` East.

Rocky shoals extend up to 2 kilometers sea ward on the north and north east side of the headland.

A small islet lies south east of Ras Abu Hashafa, it is surrounded by shoals and sandy spit with a least depth 1.8 m extend about 5 kilometers east south east.

**Ras Hawala :**

A small promontory lies on latitude 31° 12` North and longitude 27° 34` East. The promontory is fringed with submerged (sunken) rocks and is backed by low lying wet swamps.

* Mersa Hawala lies on the east side of Ras hawala

## References :

1. Abdel Salam, M. A and Elwan, A. (1970): Evolution of Dhabaa Area, from aereal photo and their bearing on land use, bull inst de Egypte, vol. XX. Cairo.

2. Bird, E.C.F. (1978): Coasts "An introduction to Geomorphology 4 edition, London.

3. British Admirality (1976): Medireranean Sea pilot.

4. Gremona, J. (1988): A field Atlas of the sea shore, London.

5. Davies, J. I. (1980): Geographical Variations in Coastal Geomorphology, Longman, London.

6. El Shami, et al., (1969): Contribution to the Geology of El Dhabaa Area "Western Meditterranean Littoral Zone, the desert institute, Bull Egypte, vol. XIX, No. 1.

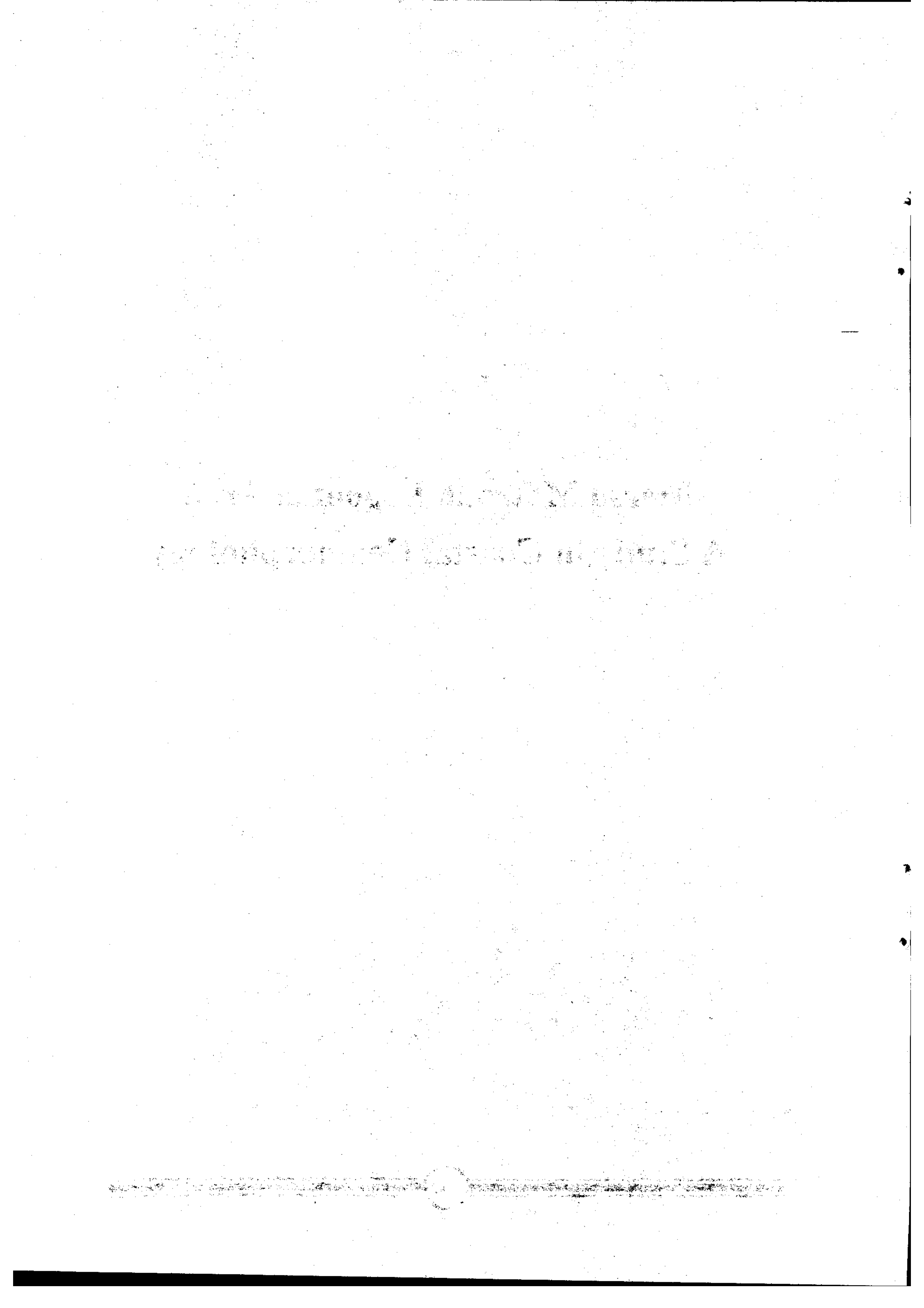
7. Philip, G., Morpohology of Meditterranean Coastal area between Rosetta and Salum, Egypt.

8. Shukry M. M. and Philip and Said, R. (1965): The Geology of the Mediterranean sea coast between Rosetta and Bardia, Bull institute, d' Egypte, vol. 37, pp. 395 - 427.

9. Sunumura, T. (1992): Geomorphology of Rocky Coasts, John Willy and Sons, Singapore.

10. Tadros et al. (1967), Yehia, M. A. et al. (1985): Analysis of the main land form patterns of the coastal Area of the western desert, Cairo.

# Mersa Matrouh Lagoonal Area
# A Study in Coastal Geomorphology



# Introduction

The area under study is a small lagoonal depression, located at about 12 kilometers east of Mersa Umm Rakham and at about 8 km west of Ras Alam el Rum. The total area is approximately 15 square kilometers, with stretching low lying shore for more than 29 km in length. (Figure 37).

According to topographic features, the area can be divided into three geomorphic units.

- The coastal barrier.
- The lagoonal depression.
- The southern oolitic limestone ridges.

Mersa Matrouh lagoonal area is very important in assissing potential environmental problems and geomorphic hazards resulting from the irrational human activities in this distenctive area with its fragile sensitive environmental systems.

Mersa Matrouh the capital of Matrouh Governorate, with its white sandy, beachs, coastal rocks, coastal lagoons and so many attrctive places for recreation and tourism activities, such as Rommel Museum in the eastern harbour of Mersa Matrouh, Rommel Sandy beach, Cleopatra Bath which lies 12 kilometers to the west of Mersa Matrouh, Ageeb attractive rocky beach which is situated 35 kilometers to the west of Mersa Matrouh and could be reach by car, etc. (Figure 38).

The study aims to reveal the physical and geomorpohological aspects of the lagoonal depression which reflect the influence of several physical factors in adittion to human impact through various land use and other human activities in coastal' and marine environment.

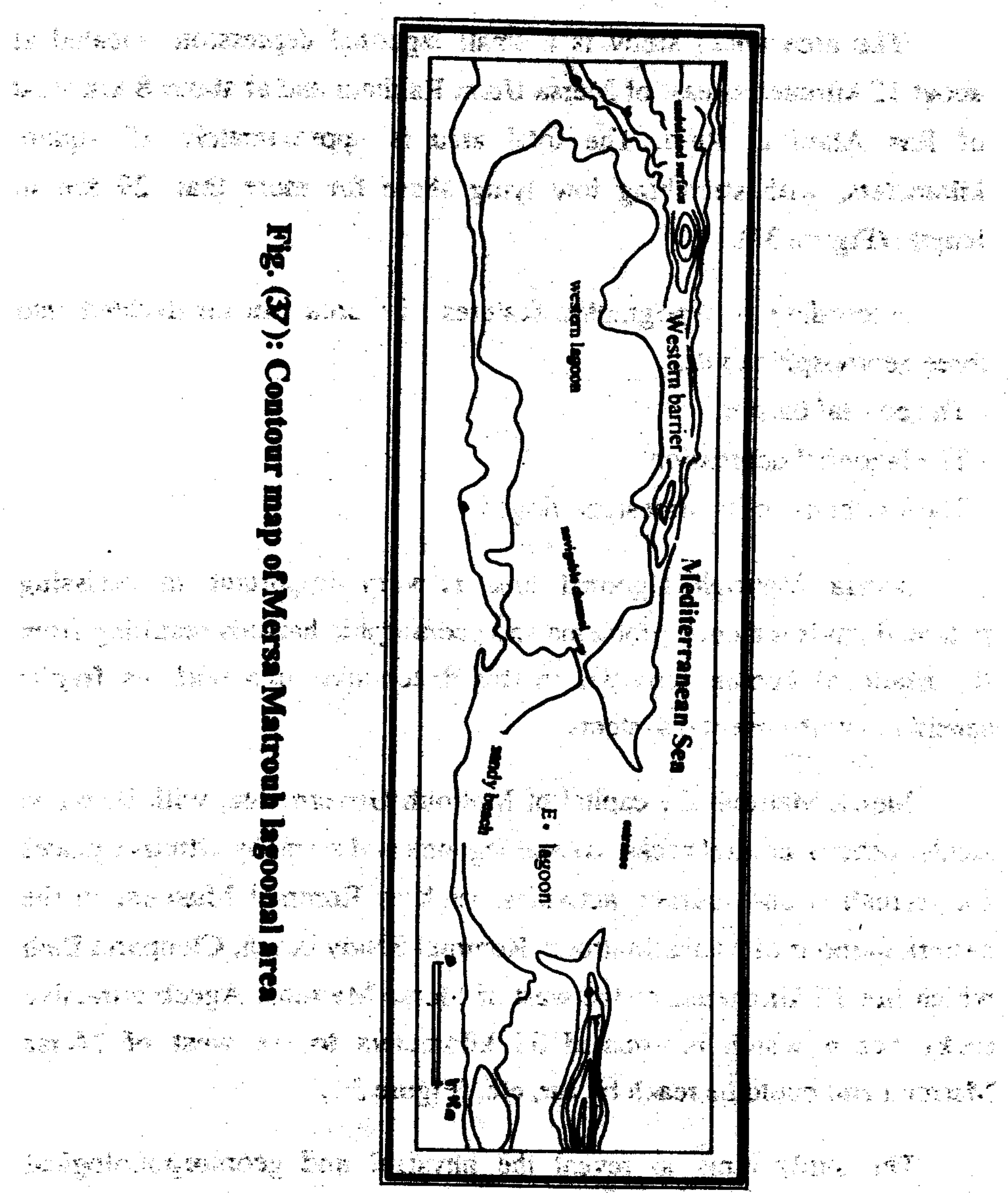



**Fig. (37): Contour map of Mersa Matrouh lagoonal area**

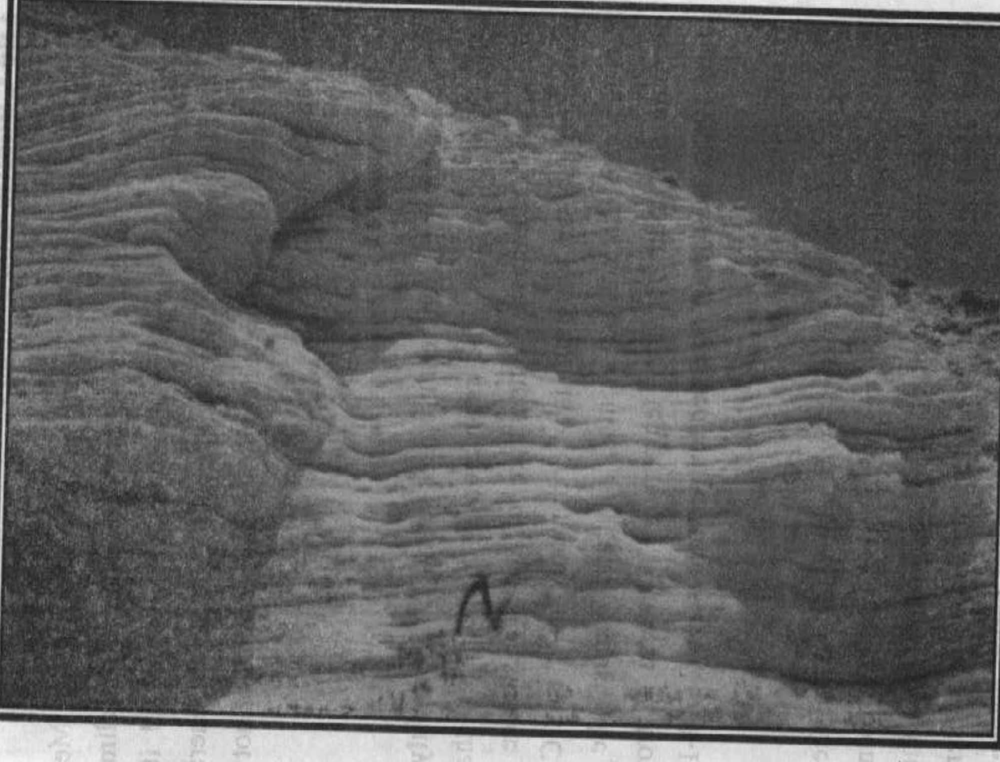


Fig. (28): Ageeba Cliffs

# Physical Environment

## The Climatic Conditions :

The climate of the coastal area (coastal strip) of Mersa Matrouh combines the characteristics of the Mediterranean sea climate with the semiarid type. It changes gradually towards south till it becomes a combination of semiarid with arid climate. Generally typical Mediterranean climate prevails with its main features of hot summer and mild rainy winter.

### Air temperature :

In summer the temperature rises steadily to 27° in July the heighest value 30°C in August. The mean monthly range is less than 10°C. The difference between the temperature of the sea surface and the air temperature - over lying air - is seldom more than 1° to 2°C. January and February are the coldest months. July and August, the hottest. The absolute maximum recorded temperature at Mersa Matrouh is 45°.5C (June 1961); the lowest recorded temperature is 1.4°C (7-1-1964).

### Wind :

On shore northen westerly winds blow for most of the winter. They bring depressions from the sea which give rise to cyclonic rains. The wind on the northern coast of Egypt as a whole are rather variable in winter. Land and sea breezes are less marked in the winter months. The gales - storms - are mainly confined to the period october to May and most frequent from December to February. The Majority are associated with depressions moving east over the sea away to the north (British Admirality, 1976, p. 18). the west and north west gales are the strongest and most frequent on the northern coast of Egypt.

The wind speed rises to more than 25 km per hour in March (Spring season) and fall to 15 km/h in October, in Summer wind are usually weak and are often offshore, cross great stretches of land and therefor not rain bringing but it may bring dust and sand from inland desert in the south.

### Rain :

Rainfall is seasional and nearly all in winter,* Much of the rain in winter and spring is associated with the cold front of depressions - cyclonic rain - which are often accompanied by thunder storms.

There is no rain in summer** and littel in Autumn. The rainy season start at the beginning of November till March as a cyclonic rain and is brought by depressions, carried in westerly winds. The total annual rain fall is about 144 mm. It varies greatly from year to year.

### Relative Humidity :

Relative Humidity is variable through the area, average monthly mean values lies mainly between 50 to 60% at noon and between 60-70 at night and in the morning. very low humidity occurs along the northern coast of the western desert during Khamasins.

## Physical Marine Environment :

### Sea water characteristics :

Include salinity and density and sea surface temperature, the first is ranging between 380% and 390% with littel seasional variation particularly in the coastal lagoons. The mean surface density of water varies from 1.026 gm/cm$^3$ in summer to 1.028 or 1.029 gm/cm$^3$ in winter.

---

* The West and North West gales are usually follow strong winds from South West.

** In the dry season from June to September there is often no rain in any part of the coast.

The sea surface temperature differs between May and December by 2 or 3°C from the average for the time of the year and from January to April by 1 or 2°C.

The difference between the temperature of the sea and that of overlying air seldom exeeds 1°C.

**Waves :**

It was found that wave action on the coast is seasional in nature and is strongly associated with strong on shore wind*.

The winter known to be the season of storm, and spring is the season of swell.** the predominant directions of waves during the winter are west and north west with heights ranging from 1/2 to 1.5 meters, the maximum wave height recorded is about 5 m. Most of wave types along the coast are constructive, but during surges erosion along the rocky coast and sandy shoreline is predominantly physical, owing to hydroulic pressures from the pounding received by waves. As the sea cliffs of oolitic lime stone barrier retreate, land ward, continued wave abrasion forms wave cut platform** extending from the base of the cliffs toward the sea for a distance of more than 200 m in some positions.

When waves approach a shoreline the water is slightly raised near shore by a slow shore ward drift of water, producing a process of beach drifting and long shore current which is capable of moving sand along the bottom in the breaker zone, in a direction parallel to the shore line ***(Strahler, 1980)***

---

* It is strongly related to large scale pressure systems (Khafagy and Manohar, 1979).

** Sea cliffs and wave platforms here are features of spectacular beauty as well as habitats for many forms of life including sea mamals and shore birds.

**Tide and Tidal currents :**

Tides in the littoral zone of Mersa Matrouh coastal area are mainly semi-diurnal. the range is very small, in most places 0.3 m or less and no where exceeding 0.5 m. The tides in the two shallw lagoons of Mersa Matrouh is less than 30 centemeters as the near shor zone ***(Lakany, R., 1960)***.

Tides affect the work done by wind waves and concentrated in a relative narrow strip along the low shores of sea barrier and along the shores of lagoons.

More important is the interchange of water between the eastern lagoon and the sea through entrance (inlet) as a tidal currents.

There are many features reflect the influence of tide and tidal currents, the more pronouncing are marshes, tidal creeks, ponds and berms etc.

As a result of semi diurnal tide, the water layer weathering plays an important role in shaping the shoreline features including beaches, low surfaces, marshes and sandy sheets.

## Surface geology :

The surface geology of the area is characterized by quaternary formations which include erosional and dipositional features such as oolitic limestone, lagoonal deposits, sandy hills, sandy sheets and cliffs associated with platforms.

---

(1) The water level in the harbour may rise about 0.9 m above normal as a result of strong wind which tends to blow across the enterance from West to East during the Summer months and from East to West in Winter (British Admirality, 1976, p. 334).

The exposed geological formations consist of sedimentary rocks belonging to the Pleistocene and Holocene.

The distribution of these formations is givin in (Figure 39) and can be summarized as follow:

**- Marine to eolian sands:**

These deposits spread widely along the coastal area, in beaches and lagoonal banks, composed of fine to medium grained, poorly sorted sands, alternate with calcareous silt and little of mud.

**- Marshes deposits:**

Marshes in the area were developed owing to the filling up of shallow lagoons particularly from the eastern lagoon to Mersa Alam El Rum eastward. The marshes with their recent surfaces along the margin of lagoons developed at or close to mean sea level. Sediments in the marshes environment are dark, silty mud tend to contain organic matters, calcareous fine sands, derived from oolitic limestone owing to wind action. The deposits contain amounts of salts which appear in dried surfaces as salt crusts. The permeability of the subsoil ranging between 0.6 and 15 cm/hr ***(Abdel Salam and Elwan, A., 1972, p. 96)***.

**- The Calcareous aeolianite :**

The calcareous aeolianites due to Pleistocene and Recent, it represents ridges, it capped by a thin crust composed of brown siliceous limestone.

Originally the ridges represent old consolidated dunes. Formed a proceeding shoreline ***(Tadros, T., et al., 1960)***.

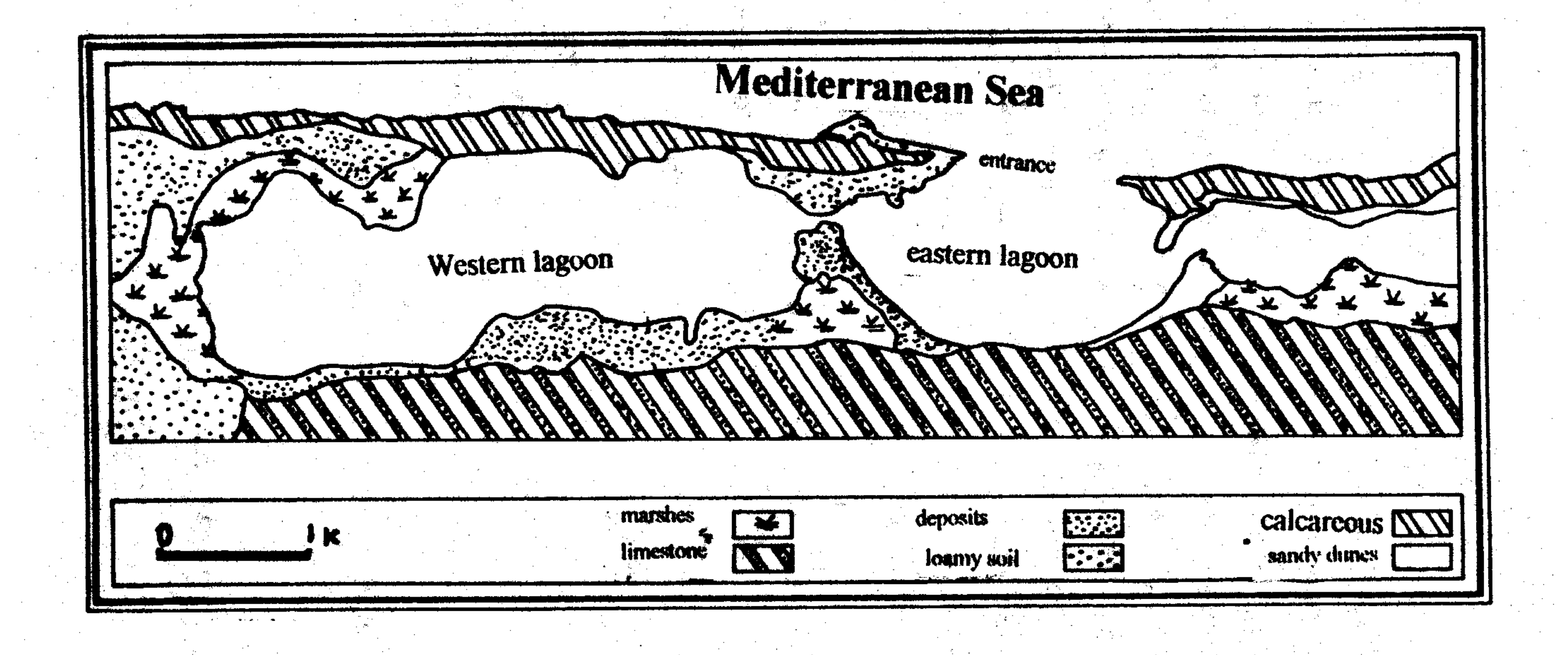



**Fig. (37): The surface deposits in Mersa Matrouh lagoonal area.**

# The Geomorphological Characteristics of Mersa Matrouh Lagoonal Area

The area can be divided into three main geomorphic units as seen is (Figure 40).

- The Eastern lagoon.
- The western lagoon.
- The sea barrier.

## The Eastern Lagoon :

It is a small longitudinal, shallow lagoon occupies* an area of about 2 square kilometers, separated from the Mediterranean sea by a narrow sandy barrier. Wide Inlet - enterance - forms the natural connection between the lagoon and the sea with a distance of 1.25 kilometers, extends between Rommel beach in the east and Gharam beach in the west. (Figure 40) shows that the length of the eastern lagoon from east to west exeeds 4 km, with mean width less than one kilometer, and total lengths of shore lines (perimeter of the lagoon) 6 kilometers. The depth of 70% of the total area of the lagoon are less than one meter. It is encumbered with sunken rocks and shoals in which there are depths of 0.6 to 0.9 m. the most important are sinussi Rocks, Askari Rocks and jaafar Rocks on which the waves break heavily even with moderate wind. Within the enterance, the channel partly formed by dredgeng with a least depth of 5.8 m (19 F) leads west and south of a large shoal area south of the barrier.

* Including the small blue lagoon (El Buhair El Zarka).

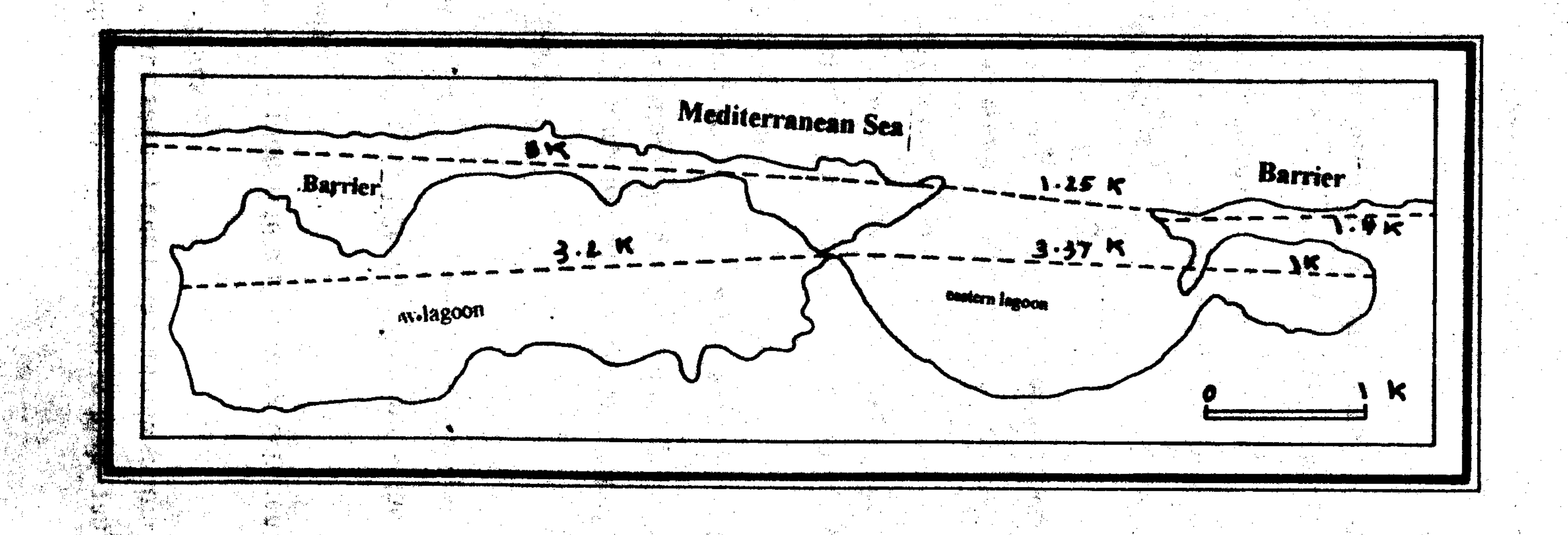



Fig. (40): Dimensions of Mersa Matrooh Lagoonal area

Water salinity of the lagoon is high, ranging between 380% to 390%, the high salinity due to the soluble sediments - calcareous - of the floor and shores.

The water timperature is ranging between 16.2°C in Jenuary and 23°C in July.

Water density is 1.26 gm/C$^3$ owing to the concentration of solved salts in the water.

## Lagoon Basin :

The main morphometric and geomorphic significance of the eastern lagoons can be summerized in the following:

- Lagoon basin occupies as large as 15% of the total area of Mersa Matrouh depression.
- The maximum length of the eastern lagoon is 3.25 km along a straight line, extends from the artrificial navigable channel in the west to the eastern bank of the lagoon.
- The maximum width is about 1.25 km from white rocks in the enterance of the lagoon to a point on the governorate beach - El Mohafza beach - in the southern bank (Figure 41).
- More than 70% of the total area of the eastern lagoon is less than one meter in depth with maximum depth about 6 m along the leading line passes partly formed by dredging.
- The total lengths of the eastern lagoon banks (shorelines) with the blue lagoon is more than 6 kilometers, including the width of the enterance (1.20 km)*

* The Ashtoum El Gamil inlet is only 200 wide.

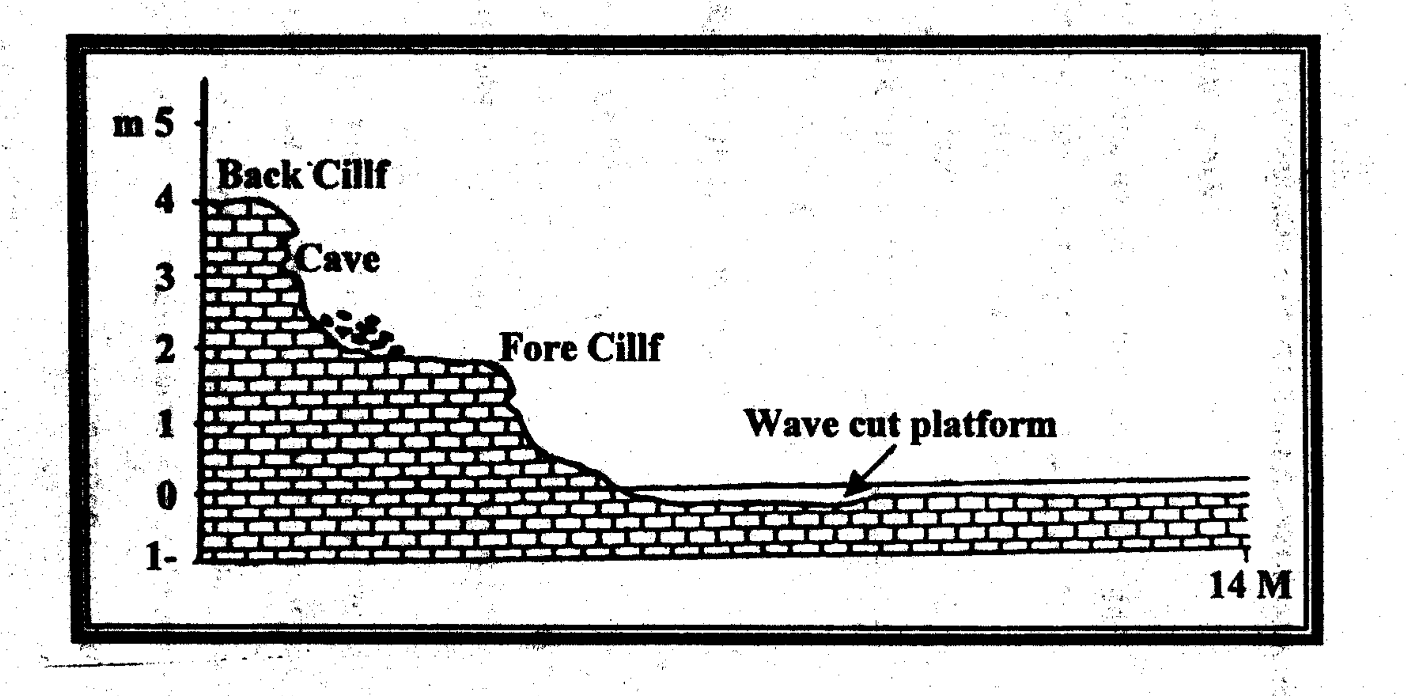



Fig. (41): A Profile in the southern shore of the eastern lagoon near Governorate building

- The eastern lagoon is an elongated algoon, has elongation ratio 0.5 and 2.6 length/width ratio.

- The lagoon floor can be divided into three distinctive areas.

• The shallow area with average mean depth less than 1/2 m, it extends close to the south west and west banks of the lagoon.

• The second area represents the artificial leading channel to the old harbour, with maximum depthe 6 meters, and width ranging between 150 and 200 meters.

• The third area in the central part of the lagoon with depths ranging between 2 to 4 meters and maximum depth about 6 m, (figure 40) indicates to the geomorphological features, of the lagoonal depression.

## The Shorlines of the Eastern Lagoon :

### 1. The south eastern shore :

Low lying sandy shore extends from old harbour toward south east direction, slope gently toward a rocky flat platform submerged by shallow water with depths less than 1/2 m and width ranging between 70 to more than 100 m. The rocky platform face, relatively deep area 6 m in depth, represents the navigable channel (Figure 44).

### 2. The southern shore :

Extends immediately as a triangular sandy low spit from the eastern side of the old harbour.

---

* These cliffs are not shaped under the present semi arid conditions, but they are considered as inherited relict due to previous humid periods it is now entirely removed owing to the intensive human activities which particularly associated with constructions and reconstructions of the urban area of Mersa Matrouh city.

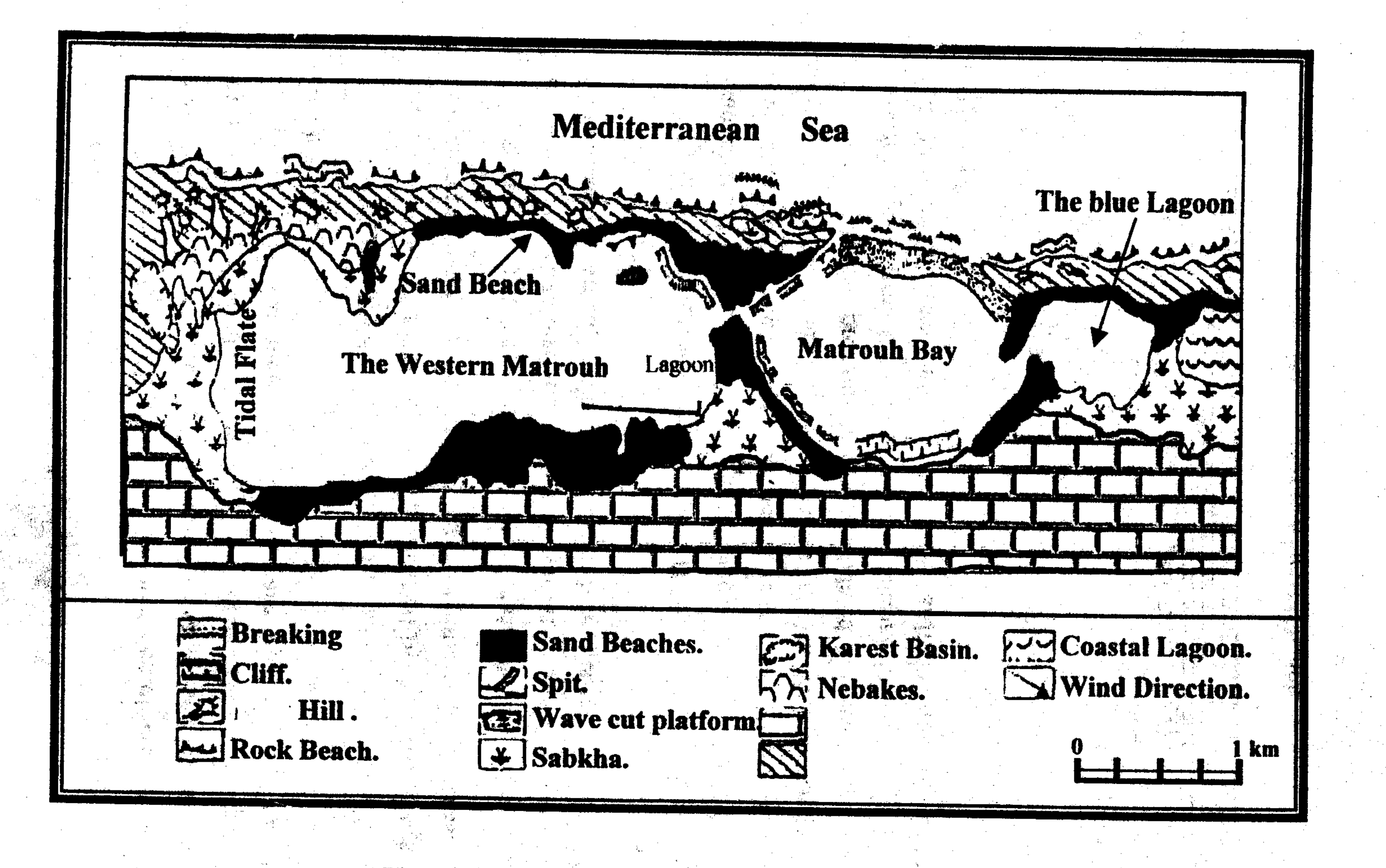



Fig. (42): Morphology of the Mersa matrouh lagoonal area.

### 3. Lido sandy beach (shore) :

This shore namely lido beach, it is composed of sub parallel low step cliffs with low lying sandy beaches. The sandy beaches are backed by low dissected double steps-slope over wall - these low cliffs are formed and developed under the effects of wave breaking and water layer weathering.

The weatherd and eroded materials derived from the retreating low cliffs as a result of marine erosion, trnasported by reflected waves and tidal currents toward the lagoon, forming the whitish sandy beaches.

Figure (43) shows profile represents the double steps cliff, fronted by broad cut wave platform - lagoonal platform - and rudaceous talus, accumulated down slip faces of the low cliff, results from mass wasting in this site.

The south west and western shore (Lido and Bousit beaches) is characterized by the presence of long sandy beach, extending in the lagoonal shallow water toward the reach of the artificial channel with slight slope for a distance of more than 300 m. The Western parts of this shores were in the previous times consolidated low bars, separate the western lagoon from the eastern one and became in the present time a link between the two lagoons through the artificial dredging channel (figure 43).

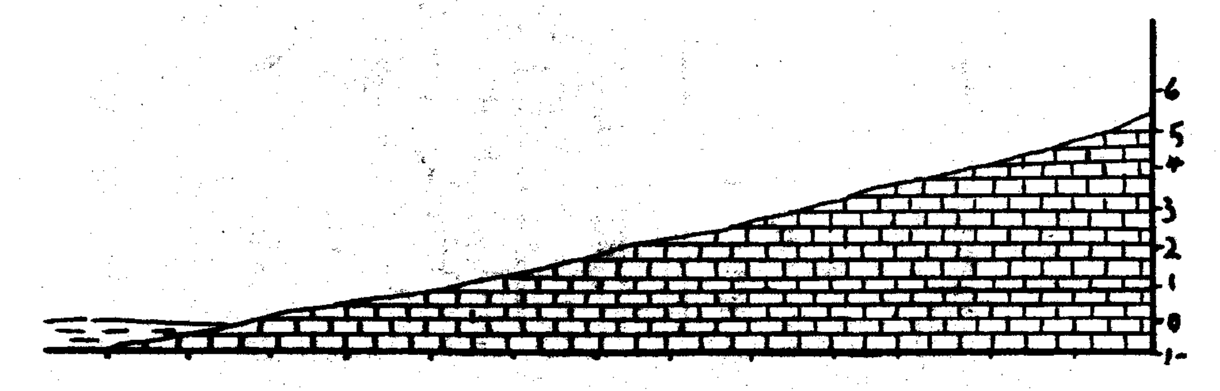



**Fig. (43): A profile in Bouset beach**

## Western Lagoon :

Is a small longitudinal lagoon, entirely separated from the sea by a narrow relatively elevated sandy barrier, extends from east to west for more than 3 kilometers.

The maximum length of the western lagoon, from the reach of the artificial channel in the eastern extremity of the lagoon to the western shore is more than 4 kilometers.

The width of the lagoon is ranging between 900 meters in the eastern part to 1.2 km in the west*.

The total area of the lagoon is 4.5 square kilometers, or about 45% of the total area of the lagoonal depression of Mersa Matrouh.

The total length of the shore lines is more than 10 km, these idented low sandy shores are backed with sandy low hills.

The lagoon is shallow with depths of 5.5 to 9.1 m (18-30 ft)** the middle part of the lake is the deepest part (9 meters).

## The Southen Shoreline :

Shoreline is low lying with broad sandy beaches, replaced west ward by low cliffs backed by approaching southern oolitic ridge which rises to an elevation of more than 10 meters above sea level.

---

* Length / Width Ratio of the lagoon is more than 3.5, this value indicates to the elongation shape of the western lagoon.

** In 1980 a port was nearing completion in the southern shore of the western lagoon. the enterance channel to the port and the turning basin were to be dredged to a depth of 9 m. A quay 100 long and with a depth of 12m was constructed to accomodate vessels up to 12000 tons (British Admirality, 1972, p. 100).

All the area of the southern shore - of western lagoon - is occupied by the constructions associated with the new harbour*.

The western shoreline is low marshy shore adjacent to west swamp, extends west ward of the lagoon for a distance of about 700 meters. The total area of the wet marsh - swamp - is about half square kilometers, bordered from west by contour line +5m.

The western wet marsh is filled with calcareous loamy soil formation, mainly representing the weathering products of oolitic sandy dunes. Wherever close to the lagoon, the soil become strongly saline.

The thickness of the deposits is variable and depends on the original micro relief prior to their accumulation.

The wet marsh is exposed during low tide in the western lagoon and submerged at high tide. It is subjected to alternate wet / dry weathering.

The scattard halophytic plants trap sediments forming low sandy mounds and smal embrionic tail dunes. As a result of high temperature during summer months, associated with over rate of evaporation the soil contents of salt increases forming vast patches of salt crusts particularly on the elevated margins of the marsh.

---

* It appears to have been extensively used by the Romans as a harbour, there are numerous ruins and remains of aqueducts. The ruins of old Matrouh, the ancient town are situated in an oasis at the west of the lagoon.

## Sea Barrier :

The sea barrier separates the eastern and western lagoons from the sea. It can be divided into two parts, the eastern barrier and the western one.

The eastern barrier extends as a straight narrow ridge of consolidated calcareous rocks from the eastern side of the eastern lagoon enterance, eastward for 1.4 kilometer with maximum elevation 20 meters above mean sea level (Figure 46) and width ranging between 200 to 375m.

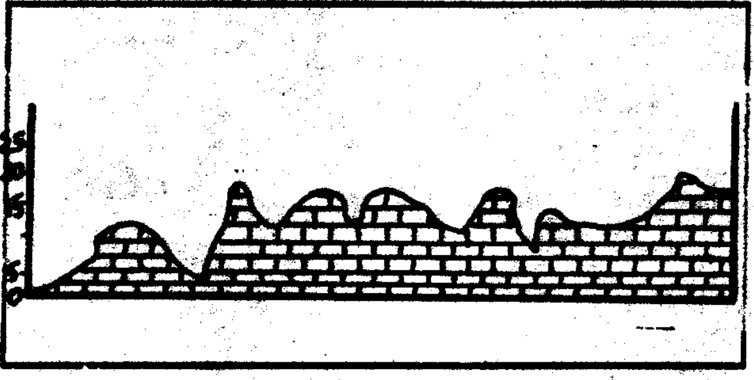


**Fig. (44): A profile along the eastern barrier**

The surface of the eastern barrier is irrigular and undulated (Figure 45) indicates to the surface relief

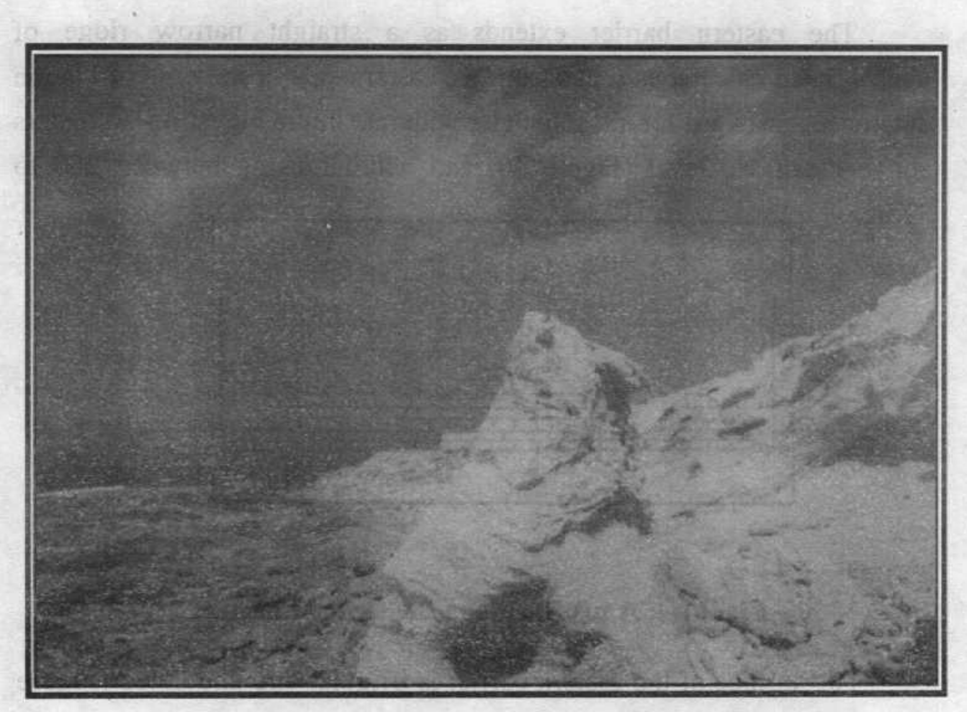


**Fig. (4[illegible]): The western extremity of the eastern barrier. It is rugged and it is influenced by the wave action. (near Rummel Meuseum)**

Minor gullies - ravines cross the surface and most of the watger accumulated from heavy rain (showrs) in winter is carried by these gullies down to the sea or to the eastern lagoon, causing lowering of the barrier and filling the lagoon with sediments, in addition to form pocket sandy beaches on sea ward side which can be seen clearly extending and overlying the bed rock of the marine platform.

The surface of the barrier is characterized by occurence of small depressions, filled with calcareous loamy soil formation, mainly representing the erosion products of the bed rocks. Nagret El Beloushy is the main shallow depression,* situated near the eastern side of the enterance (figure 47), its bottom is covered partly with species of halophytic plants, which trap sediments forming hummocky surface, pronounce within flat areas, covered with salt crusts.

The sea ward side of the barrier is subjected to varrying degrees of fluvio marine erosion, it slope steeply toward gentle sloping platform without significant break.

The wave cut platform extrends from the base of the steep scarp (cliff) to the shallow nearshore below low tide level. The steep scarp (sea ward side of the barrier) with slope angles range between 30-40 degrees is exposed to the intensive wave action, interrupted by cracks and joints.

The erosional features such as sea caves, stacks, rampats** are usually associated with a geological weakness.

---

* It represents a local catchment area.

** Rampat is a ridge rising a meter or more bove the general level of platforms at their sea ward margins, such ridges were first called rampats by wentworth 1938 in his study in Hawaii (Sunamura, 1993).

The northern shore of the eastern lagoon is indented low shore by several bays alternate with micro cusps produced by wave refraction and swash paths.

Figure (46) indicates to swash paths around cusps and within empayments on sand beach near Mersa Matrouh *(Derbyshire, E., et al., 1979, p. 150).*

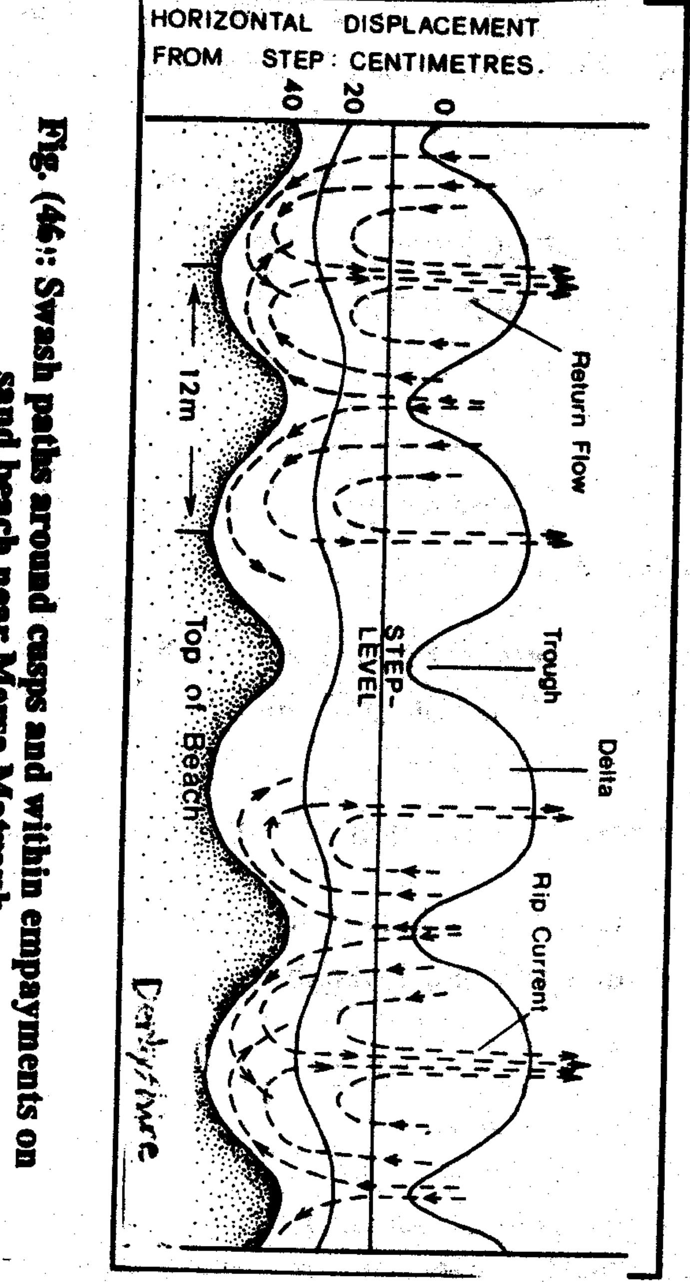



**Fig. (46): Swash paths around cusps and within empayments on sand beach near Mersa Matrouh**

Bay of Rummel beach is the main one along the northern shore of the eastern lagoon, with depths ranging between 20 centimeters to 150 centimeters.

## The Western barrier :

The western barrier separates the western lagoon from the Mediterranean sea, it extends from west to east for a distance of 5 km with slight curvature to south east toward the enterance of the eastern lagoon.

The width ranges from 75 meters in the vicinity of the artificial channel in the eastern extremity of the barrier to more than 650m in its western end.

The length of the northern shore line - sea side - is 6 k.m, but the lagoonal shore line - the southern side of the barrier - is more than 7 km.

The total area of the western barrier surface is about 1.5 $km^2$, with an elevation ranging between less than half meter only in the eastern extremity - El Gharam beach - to 22 meters in the west backshore of Cleopatra shore.

### The surface of the western barrier :

The surface of the barrier is irrigular undulated composed essentially of consolidated white oolitic sand grains.

Sand sheets and low sandy vegitated mounds occupy patches of the surface particularly in the western extension toward the coastal swamps.

The eastern extension of the barrier - along a distance of 300m is a low platform with elevation of about 2 meters above sea level, it is subjected to intense, severe marine erosion (Figure 47).

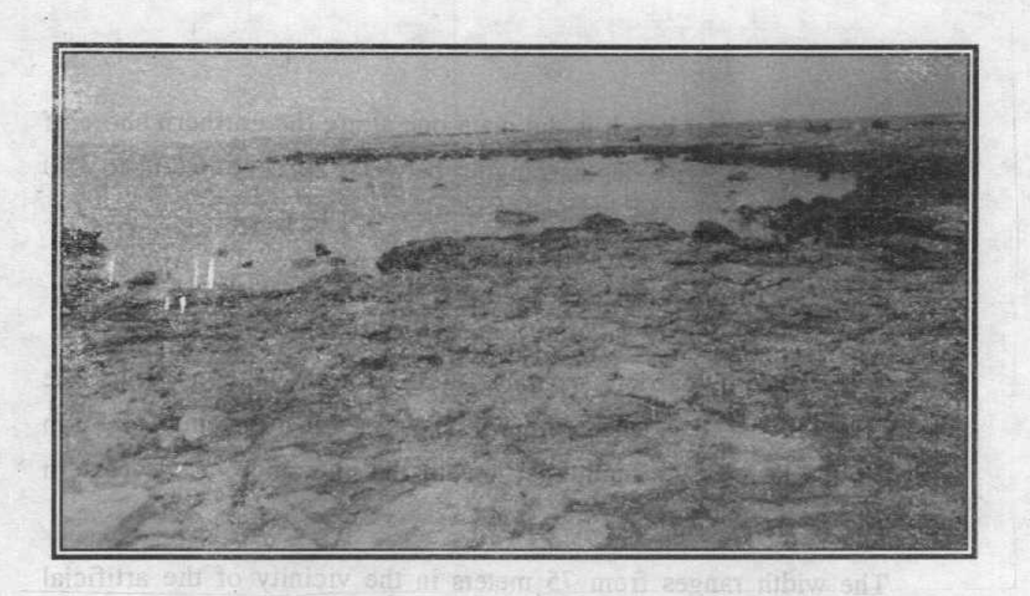


**Fig. (47): A rocky rough surface of platform with shallow small bay**

Ths platform consists of hard rock - consolidated oolitic limestone - dissected by cracks, holes and fissures. Some few stacks and pedestal rocks scatter over the surface. These erosional land forms, produced as a result of wave action.

The western extenstion of the barrier - represents an oolitic, longitudinal ridge - with elevation ranges between 0 to 22 meters. Unconsolidated sandy mounds and elongated frontal dunes occupy almost the area of this extension .

Almost of the sandy forms are impeded by intensive growth of plants.

The northern side of the western barrier slope steeply toward the sea. The sandy beaches localities are usually backed by steep, dissected low cliffs and fronted by relative broad rocky platform extends irrigullarly seaward for more than 8 meters wide.

Cleopatra Bath* is a rocky wave cut platform, lies 12km to the west of Mersa Matrouh. It is characterized by occurence of conspicuous marine stacks (Figure 50) indicates to main stacks, rise about 4 meters above the platform and scattered rocks represent a residual features with heights not more than 50 centimeters above the general level in this site.

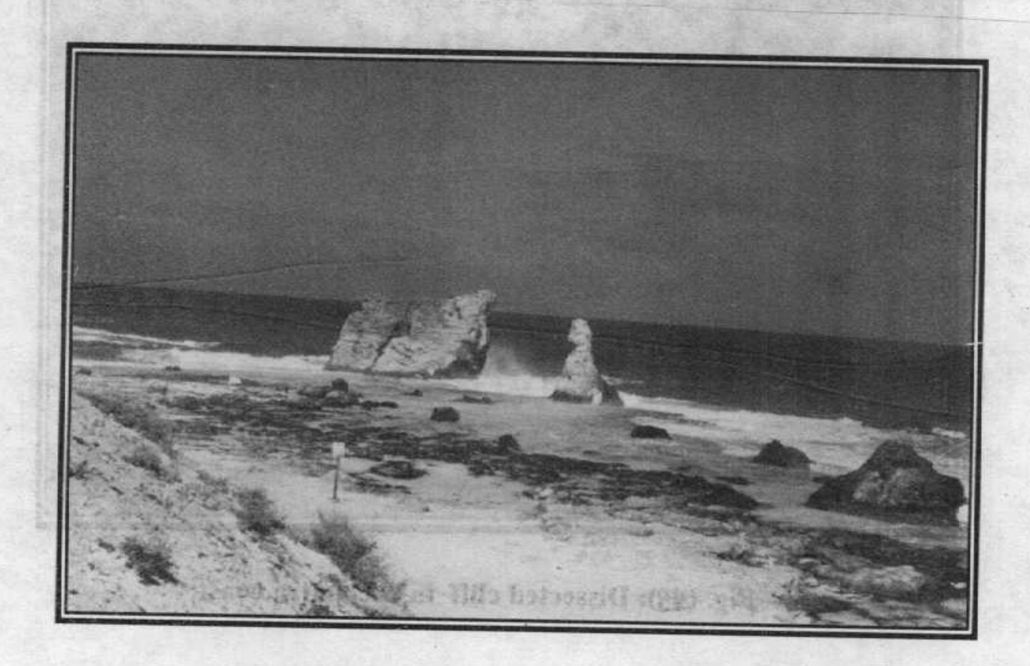


**Fig. (٤٨): Marine platform with two conspicuous stack in Cleopatra coast.**

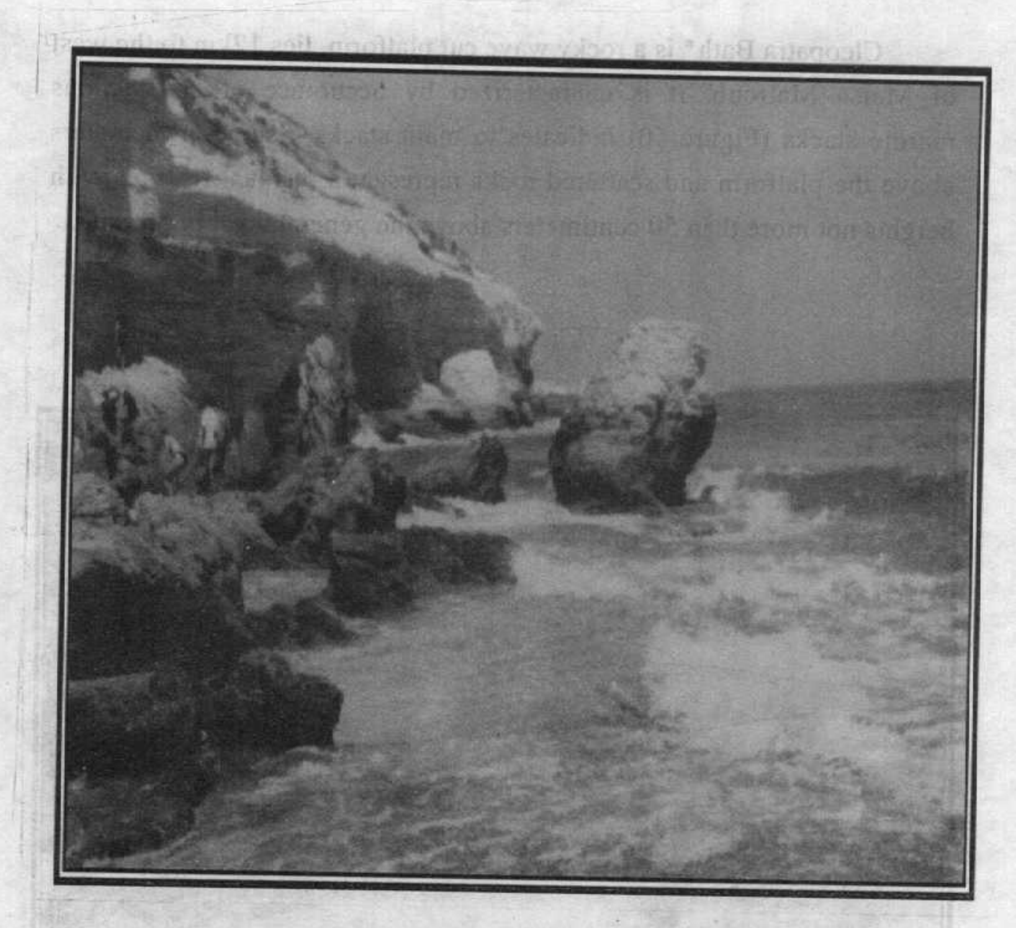


**Fig. (٤٩): Dissected cliff in Cleopatra coast.**

The sandy beach of Cleopatra coast is fronted by the rocky platform mentioned above and backed by the base of retreating dissected cliff (figure 49). The beach width is ranging between 15 and 50 m, with slope angels less than 2 degrees.

The southern side of the barier slope moderately toward the western lagoon, (figure 50).

The beach is a sensitive form and can be regarded as the most dynamic system of the physical landscape in which processes affect the form of the beach through the dispersal of its composed unconsolidated sediments. It cointinually exhibits temporal variations in morphology (Abu Radi, F., 1997, p. 63) (figure 50).

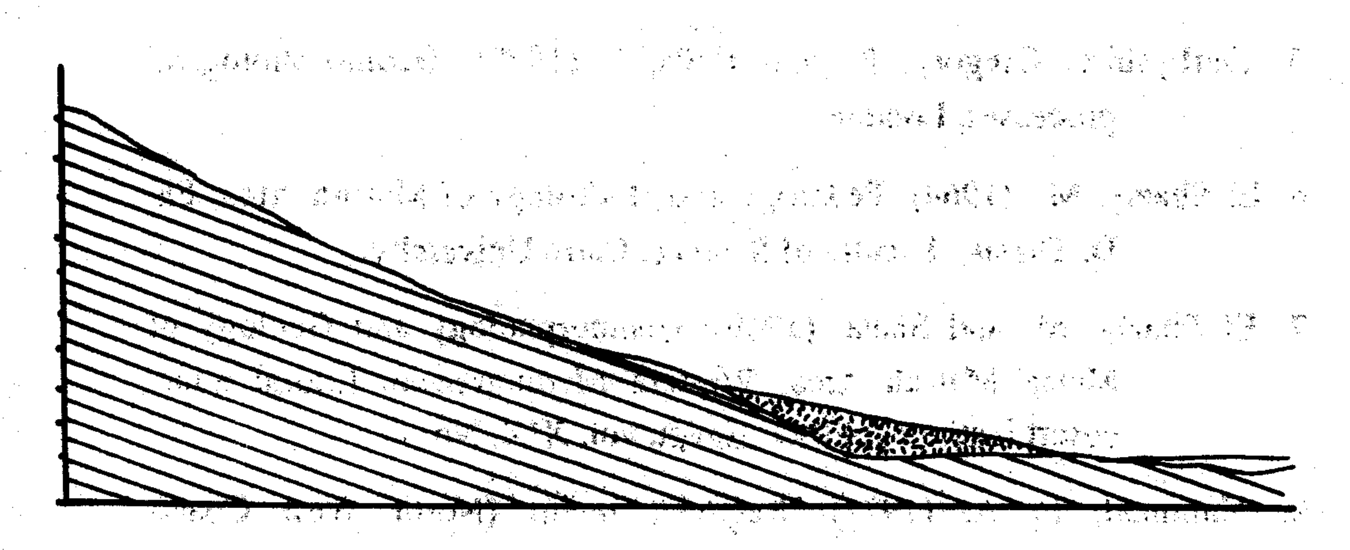


**Fig. (٤٢): A profile on the southern side of the western barrier**

## References :

1. Abdel Salam, M.A. and Elwan, A. (1970): Evaluation of Dabaa Area from photo and their bearing on land - use, bull, institute de Egypte, vol. XX.

2. Abu El Enin, H. (1975): Mersa Matrouh area and its neighbours - A study in Geomorphology. Bul. dé soc. d' geog. d' Egypt, Cairo (in Arabic).

3. Abu Raddy, F. 91997): A Multivariate Analysis of spatial variations in Beach morphology and their relations to Nearshore Processes along the Coast of Alexandria City, Bull d' la soc d' Geogr de Egypt, Vol. 70, Cairo.

4. Davies, J.L., (1980): Geographical variations in Coastal Geomorphology, Longman, London.

5. Derbyshire, Gregory, K. and Hails, J. (1979): Geomorphological processes, London.

6. El Shazly, M., (1964): Pedology and Hydrology of Matruh Area, Ph. D. Thesis, Faculty of Science, Cairo University.

7. El Shazly, M. and Shata, (1969): Geomorphology and Geology of Mersa Matruh Area. Western Mediterranean littoral zone, desert institute, bull D' Egypt, vol. XIX, No. 1.

8. Hammad, F. A. (1972): Regional report (North West Coast) unpublished report, desert Institute, Cairo.

9. Hilmy, M.E. (1951): Beach Sand of Mediterranean Coast of Egypt.

10. Lakany, R., (1960): Mersa Matruh (the Egyptian Reiviera and its environment, 2ed, Alexandria.

11. Mediterranean Pilot (1976)(: Coasts of Libya, Egypt, Israel, Lebanon, Syria and other countries, Ministry of Defence, England.

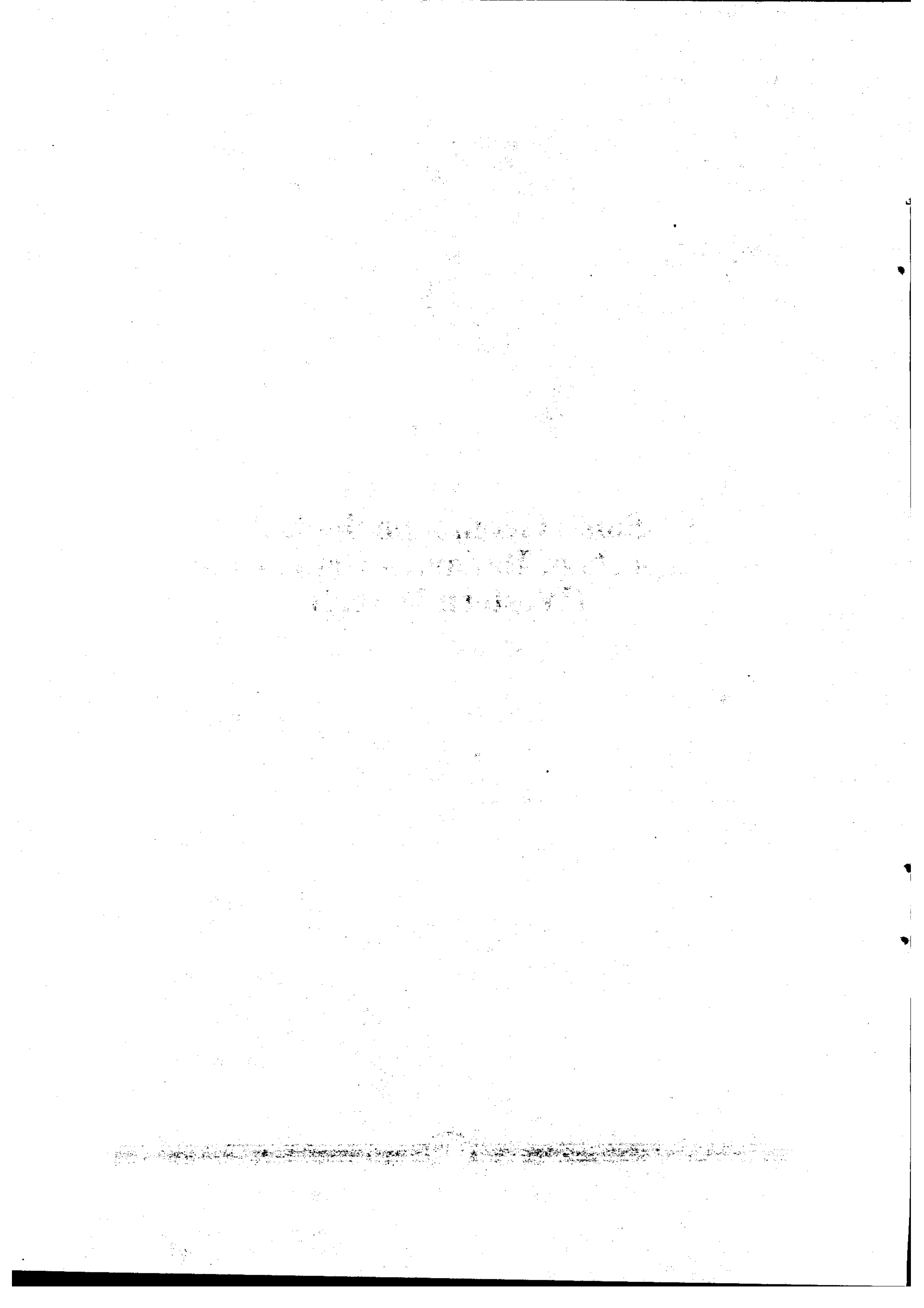
12. Philip, G. (1950): Morphology of the Mediterranean coastal area between Rositta and Sallum, Egypt, in proceeding.

13. Selim, M. S. (1994): Coasts of Egypt - Researches in coastal Geomorphology, Cairo (in Arabic).

14. Safie El Deen, M. (1977): Land forms of Egypt, Cairo, (in Arabic).

15. Shukri, N and Philip, G. and Said, R. (1950): The Geology of the Mediterranean Coast between Rosetta and Bardia, Bull ins. D'Egypte, vol. 37, pp. 395-427.

# Some Geomorphological Aspects of Bahariya Depression (Western Desert)



# Introduction

Baharia Depression lies between latitudes 27° 48` and 28° 30` north and between longitudes 28° 35` and 29° 10` east.

It is a large oval shaped excavation in the central limestone plateau of the western Desert (Figure 51 ). It differs from the other depressions which are open on one or more sides, in being entirely surrounded by escarpments and in having a large number of isolated hills within the depression.

The greatest length of the depression north east to south west is about 94 km; and its greates width measured at right angles to its length is about 42 km. The total area of Baharia Depression is more than 1800 square kilometers. The average depth from the general desert plateau level to the floor of the depression is less than 100 meters ***(Said, R. 1962, p. 214)***.

From the depression roads* lead to the Nile valley and to other depressions in the western Desert.

Most of the villages of the depression and cultivated land are concentrated between latitudes 28° 21` and 28° 22` North. In that area there are many springs and wells. The water of the wells has a high temperature and contains bubbles of carbon dioxide, suggesting that the water actually comes from great depths similar to those of the Dakhla and Kharga Oases, the wells must be cleaned constantly ***(Abu Al Izz, 1971, p. 218)***.

* One road leads to Al-Minya. Another road reaches the Farafra Oasis and a third road leads to Al Bahnasa in the valley.

Three main geomorphic features are distinguished in Baharia Depression.

1. The bounding escarpments.
2. The hills within the depression.
3. The floor of the depression, including the villages and the spring, wells and cultivated land.

## 1. The bounding escarpments :

Baharia depression - is different from the other depressions of the Western Desert in being surrounded on all sides by high rocky scarps*.

The scarp that bounds the most northerly extremity - narrow extension about 4.5 km wide - is low and less steep than that further south** .

**The eastern scarp :**

The depression opens widely aftger the north east extremity the eastern scarp extends irrigularly south and south west wards and became low and less steep south of latitude 28° 10`, with respect to northern extension. It is dissected in certain localities by faults or by dry gullies which form the gaps through which roads enter the depression. There are several minor anticlinal structures along the eastern scarp of the depression where dips up to 50° are noted. These are separated from the major anticline by a syncline of large dimensions *(Said, R., 1962, p. 85)*.

At latitude of Al-Hayis 28° North, the eastern and western scarps again draw near and the width of the depression narrows to about 15 km (Figure 5? ).

---

* In plan the depression is highly irrigular in outline, more particularly on its western side (Fig. 53).

** At this north east extremity a black hil namely Gebel Ghorabi rise 300 m above sea level within a narrow extention.

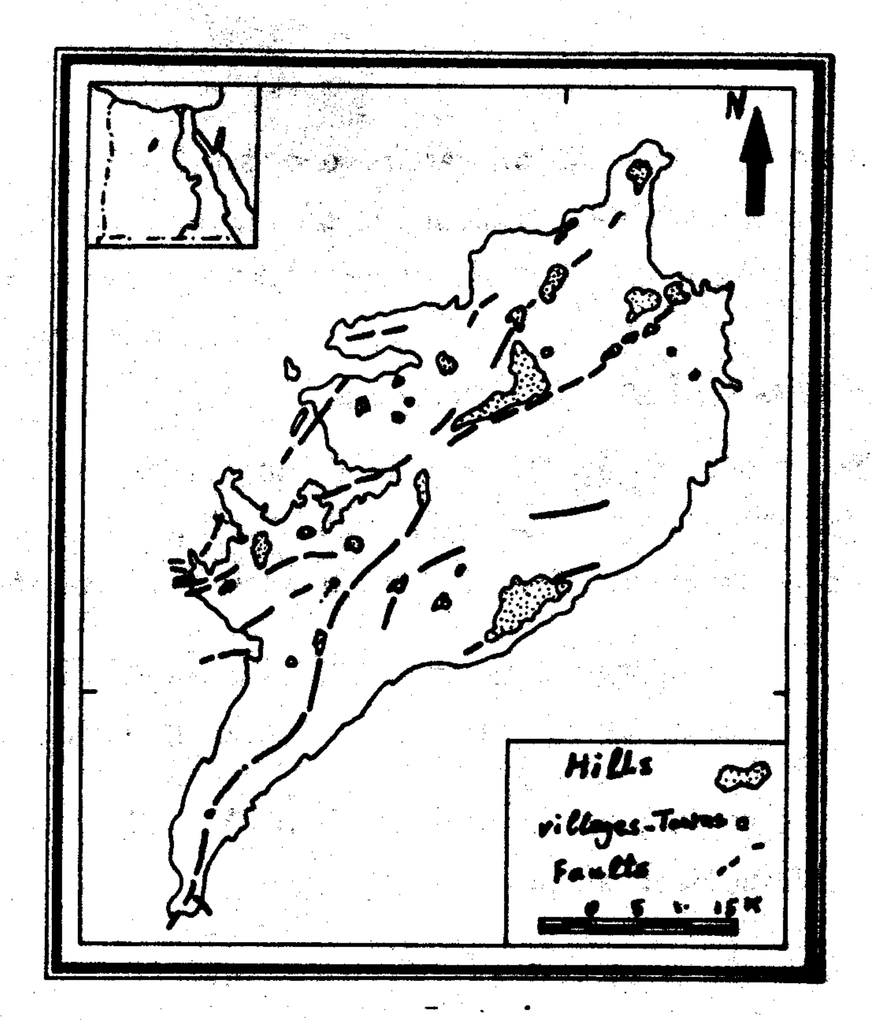



**Fig. (51): Bahariya Depression**

**The western scarp :**

Extends from the north eastern extremity of the depression south west ward for about 20 km before it turns and runs for about 5 km south, forming a prominent headland about 2.5 km north west of El Qasr town. The headland is the boldest part of the whole depression scarp, it attains a height of 175 m above the lowest part of the bottom of the depression.

The western scarp (wall) is composed of three successive scarps, the outer one is composed of chalk which crops out forming a well-marked snow white, tortuous escarpment lying at a considerable distance from the wall. Toward the south, the chalk approaches the wall

and extends south ward to Farafra depression, the middle one is composed of nummulitic limestone and the interior scarp of nubian sand stone similar to the formation of the floor of the depression. Fig 52

## 2. The Hills within the depression :

The most striking feature in the topography of the Baharia Depression is the large number of isolated hills, dispersed across the surface of the depression. The isolated hills vary in size and shape.

The most pronounced group of hills is that extending in a nearly straight north east direction, cutting the depression into two parts.

The largest hills of the group are Gebel Hefhuf, Gebel Mendisha, Maysra, El Dist, Hammad and Ghorabi.

**Gebel Hefhuf :**

It is a narrow ridge - like hill of limestone, the northern side of the hill is covered with black basaltic eruptions, being formed mainly of non-porphyritic olivine dolerite ***(Hanafy, M., et al., 1998, p. 335)***.

There are some doleritic sills intruding the dolomitic lime stone of El hefhuf formation, may be seen obviously on the western slopes of the hill (Figure 51).

It situated north of the cultivated areas with mean elevation about 250 m above sea level tends to increase south west ward.

**Gebel Hamad :**

It is one of the largest isolated hills within the depression, lies west of Gebel Hefhuf, appears as an elongated, flat topped hill, entirely capped by brown limestone rises to a height of more than 130 meters above the level of the local surface.

**Gebel Mendish :**

A large dark dolerite - capped hill extends across the cultivated part of the depression, between Zabou and Mendisha villages in the east and Bawitiy - El Qasr in the west. This steep sided hill, affected intensevely by physical weathering and gullying.* Vertical columnar jointing is observed in hill sides.

**Gebel Maysara :**

A triangular shaped hill, rises a desert pavement with a heigh of 215 m above sea level, kends to increase south ward.**

It is a flat topped hill shopes steeply west ward and gently south ward (figure 51).

Gebel Mayisra lies north east of Mandisha hill, the dark color of this block, once attributed to eruptive basalic rock.***

**Ghorabi Hill :**

At the most northerly point of the depression, there is a narrow bay (extension, about 4.5 km wide enclosing a large black hill, Gebel Ghorabi which rises 300 m above sea level, with iron ore beds capping it. The dicovery of a nummulitic fauna in some pockets within this bed clearly indicates that the age of this iron ore deposit is middle miocene ***(Said, R., 1962, p. 85)***.

---

* The dolerite caps Gebel Mendisha and Gebel Meysra and is intruded as a sill in the cretaceous rocks of Gebel Hefhuf.

** 130 meters above the surface of the depression.

*** The coarse - grained olivine dolerite occupies the upper and top most parts of Mendisha and Mayesara flow and the upper sill of El Hafhuf (Hanafy, M. et al., 1998, p. 334).

There are a number of small hills near the scarps of Baharia depression and in some localities above the floor. Almost of these hills rise above the surface as conical buttes( fig 53)

A small number of hills are composed of white limestone. The most important group of the isolated hills is found to the south of the cultivated area (figure 51).

**Depression floor :**

The floor of Baharia depression is in general level and has no marked peculiarities except for the conspicuous and isolated hills.

The lowest point of depression floor is in the neighbourhood of El Qasr Where the altitude above sea level is about 113 meters. To the south of Ain El Heiz (El Haiss) the floor of the depressin rises imperceptibly to about 156m above sea level. The floor is composed of Baharia formation* (sandstone and varigated shales). In the northern part of the depression they are well developed and the maximum thickness of the exposed part is about 170 m *(Said, R, 1962, p. 81)*.

In the vicinity of the scarps spread conglomerates and detritus that originated from the nearby hills.

Natural vigitation densely grow in low lying areas near the main villages around springs and wells, such as the area around Ayn Galit and south east of Gebel Hafhuf (Tahtanyia cultivated area). Salty marshes occupy vast areas of the surface particularly in the lowest localities such as in Tahtaniya and Tahkima north of the cultivated area of Bawieti - El Qasr east of El Zubu Mendisha and north east of El Harra where the altitude is 134 m above sea level.

* Baharia formation consists of friable, false bedded, varigated sands and sand stones with harder dark brown, ferruginous bands alternating with sandy shalles.

The sand accumulations occupy limited areas of the depression floor arround the cultivated low lying lands near the villages of Mendisha and Zabu where the barchan and sand drifts are the predominant forms. In between the sand dunes some trees (date palms) and other shrubs grow.*

There are many natural springs, concentrated in the low lying areas, the most important is Ain El Beshmo north east of El Bawitii and water can be produced by digging wells.

The underground water of the depression has a high temperature and contains bubbles of carbon dioxide, suggesting that the water actually comes from deep aquifers similar to those of the Dhakhla and Kharga Oases (Abu El Izz, 1970, p. 218).

The Government has turned to desert areas to establish new agricultural settlements. The Desert Research Center (DRC) was established as a governmental organization whose activities are devoted primarily to research and development in the deserts. The main activities of the DRC are Exploring and evaluating ground water aquifers, drilling and testing productive and test water wells.

Table (4) indicates to the main governmental wells in Bahariya Oasis from 1966 to 1970.

---

* Baharyia Depression not invaded much by mobile sands as are the other depressions south of it, nor there much sand on its floor except for the localities mentioned above.

## Tectonics and geological evalution of Bahariya depression:

Bahariya Depression setuated on the sothern margin of unstable shelf. It represents a domal structure or an anticline with longitudinal axis, extends north east to south west.

After the deposition of the thick deposits during Cenomanian folding took place *(Said, R. 1962, p. 85)*. The turanian - Santonian beds follow unconformably those of the cenomanian.

Further folding took place after the deposition of El Hefhuf formation and the depression site was submerged during middle Eocene.

The tectonic movements produced faults and Basaltic erruptions post eocene or during Oligocene *(Ibid, p. 86)*.

The faults and joints enabled erosion to remove the friable formations and excavate the depression.

After the first period of erosion the whole structure was occupied by a lake comprising numerous islets formed by the isolated residual hills - Mendisha - Hefhuf - Meysra etc).

The tops of those hills then were capped by the Eocene limestone *(Abu El Ezz, 1970, p. 219)*.

After the Oligocene the lake shrank and climinated and the land raised gradually. Erosion was nor active during the pluvial period of Quaternary and eolian action took over during the dissication (interpluvial periods) until the depression attained its present form *(Ibid, p. 219)*.

## References :

1. Abu Al Izz, M. (1971): Land forms of Egypt, Translated by Fayid, Y.A. Cairo.

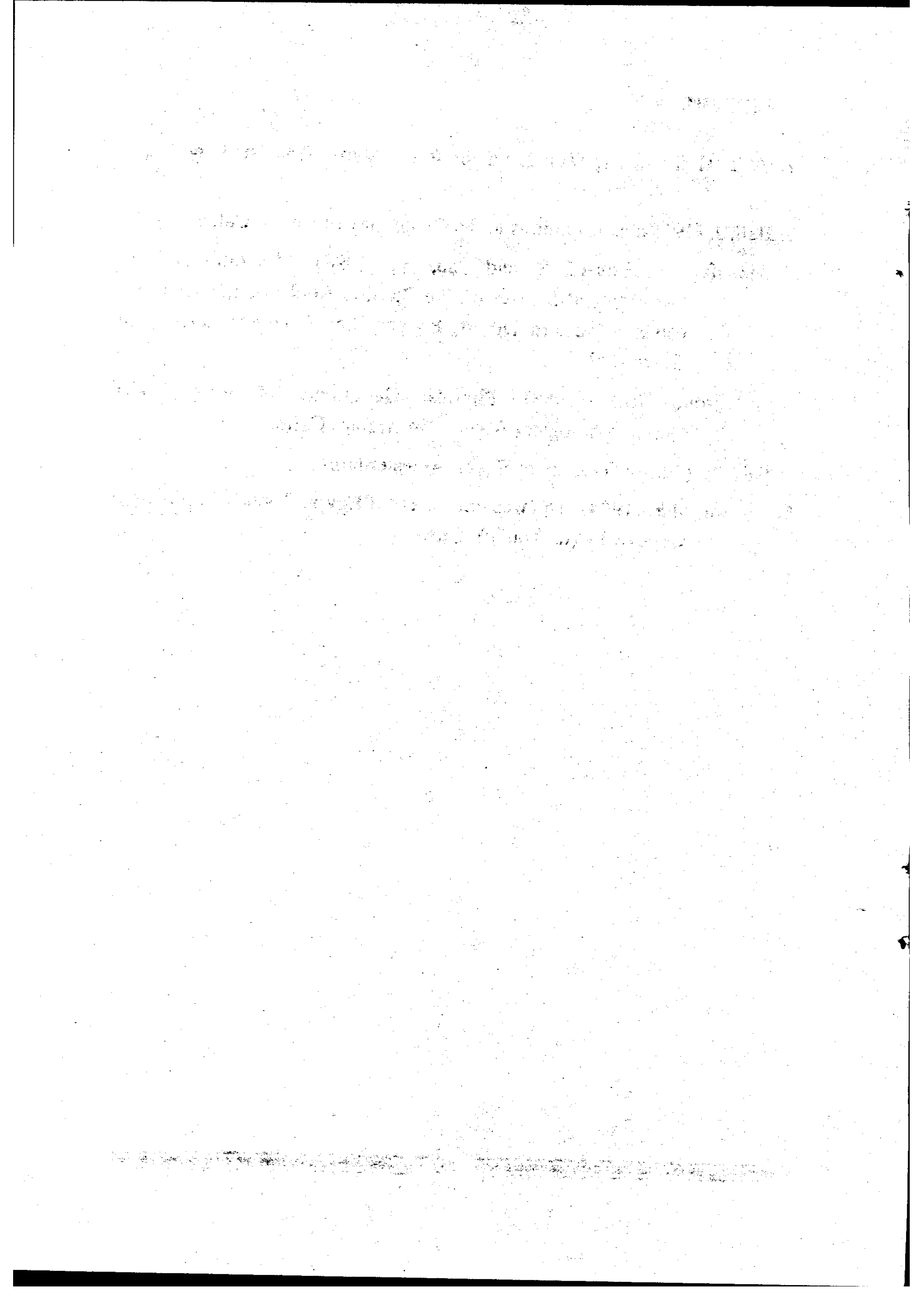
2. Ball, J. (1939): contributions to the Geography of Egypt, Cairo.

3. Hanafy, M., Yousef, S. and Gad, A., (1998): Mineralogical and Geochemical Studies on the Basaltic Rocks of the Bahariya Oasis - Western Desert, Egypt. The Geological survey of Egypt, Cairo.

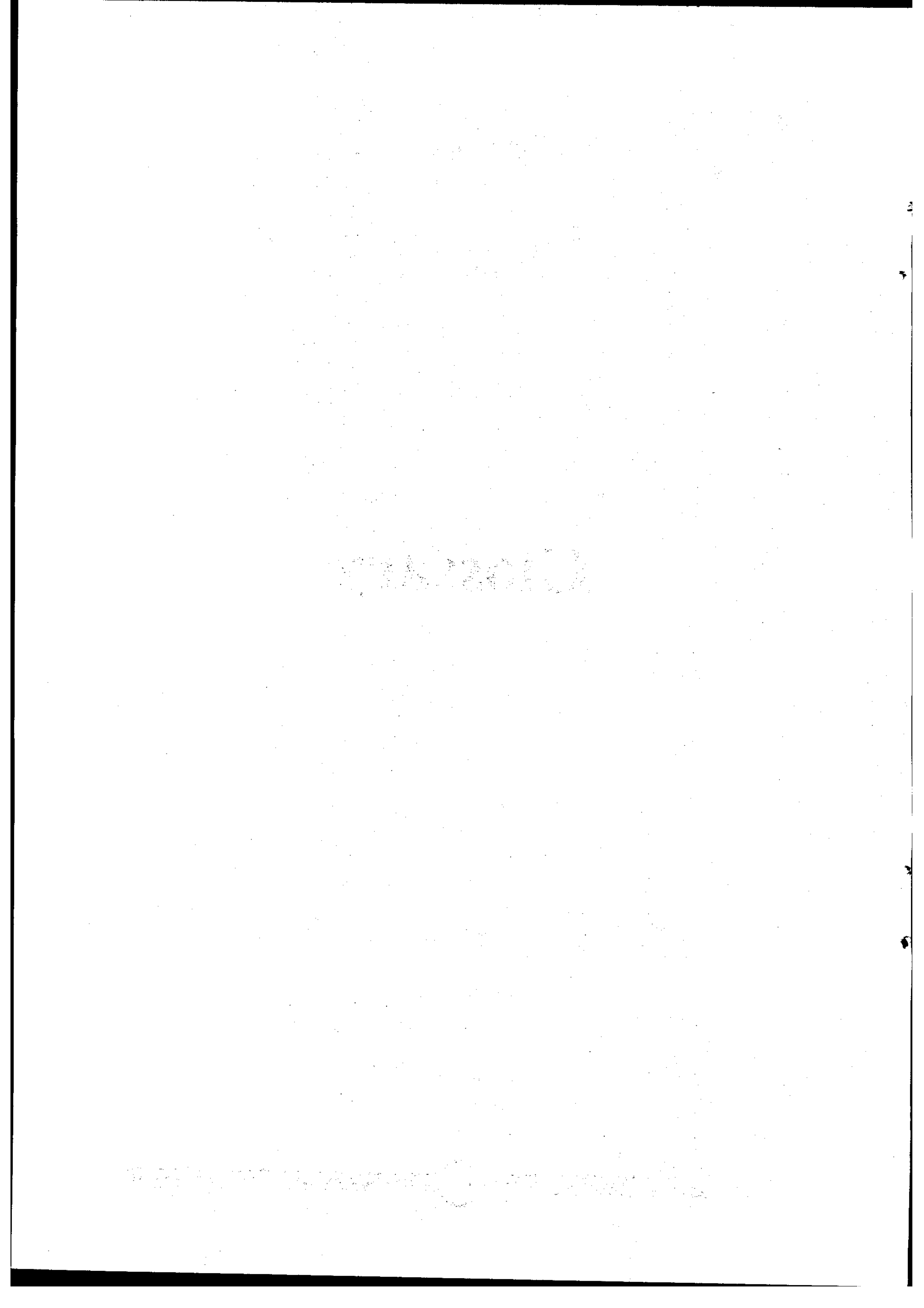
4. Mahsoub, M.S (1998): Physical Geography of Egypt, The Geomorphological Aspects (in Arabic) Cairo.

5. Said, R. (1962): Geology of Egypt, Amesterdam.

6. Saleem, M.S. (1994): The western Desert of Egypt. A study in physical Geography (in Arabic), Cairo.



# Glossary



# Glossary

| A | English | Arabic |
|---|---|---|
| ***Abrasion*** | The wearing a way of material by friction sand, pebbles or ice crystals moving in wind or runing water act to abrade surfaces that they strike. | **البرى :** برى أو تقطع المواد الصخرية بالاحتكاك ، تقوم خلالها الرمال أو الحصى أو الجليد يبرى الاسطح الصخرية التى تصطدم بها . |
| ***Abrasion platform*** | Sloping, nearly flat bedrock surface extending out from foot of coastal cliff under shallow water of breaker zone. | **رصيف البرى :** سطح صخرى شبه أفقى يمتد من اقدام الجرف الساحلى تغمرة مياه ضحله فى نطاق تكسر الأمواج . |
| ***Accelerated erosion*** | Soil erosion occuring at a rate much faster than soil horizons can be formed from the parent regolith. | **النحت المتسارع :** نحت للتربة بمعدل يفوق معدل تكونها من الحطام الصخرى الذى تشتق منه . |
| ***Alkali flats*** | Areas where the ground surface is composed of concentration of salts like sodium carbunate or sodium chloride. Commonly found in arid and semi arid regions where rapid and voluminous evaporation of water produces the residue of salty soil | **أسطح قلوية :** مناطق تتميز اسطحها بتلونها من تركيز املاح كربونات الصوديوم أو كلوريد الصوديوم وهى واسعة الانتشار فى المناطق الجافة وشبة الجافة التى تتميز بزيادة معدلات التبخر التى ينتج عنها تراكم الأملاح فى التربة . |

| | | |
|---|---|---|
| ***Aquifer*** | **Rock mass or layer that impedes or prevents the movment of ground water, it has low permeability.** | **خزان جوفى :** كتلة أو طبقة صخرية تقيد أو تمنع حركة المياه الجوفية وعادة ماتكون ذات نفاذية منخفضة . |
| ***Aridity*** | **Dry climatic conditions in which precipitation does not meat the potential moisture demands of vegetation. The deficiency results in plants and animals having specific adaptations for water conservation.** | **الجفافية :** ظروف مناخية جافة يكون فيها التساقط غير متكافئ مع متطلبات الرطوبة التى تحتاجها النباتات بالمنطقة ، ونتيجه لهذا يحدث أن يتكيف النبات والحيوان مع هذه الظروف من خلال إمكانية الحفاظ على الماء باساليب مختلفة . |
| ***Atoll*** | **circular or closed-loop coral reef enclosing an open lagoon with no island inside.** | **حلقات مرجانية :** شعاب مرجانية دائرية الشكل أو بيضية تتضمن داخلها لاجون مائى ضحل خال من الجزر وقد تتخذ اشكالاً غير متظمة . |
| ***Attrition*** | **The reduction in size and angularity of rock particles through mutual rubbing and grinding as they are carried in transit by wind, running water.** | **الطحن :** تناقص فى حجم الجزيئات الصخرية وكذلك تناقص فى حدة زواياها وذلك من خلال تصادمها مع بعضها اثناء نقلها بواسطة الرياح أو المياة الجارية فى الأنهار أو فى نطاق تقدم وتقهقر (تراجع الأمواج) ***Swash and back wash*** |

# B

| | | |
|---|---|---|
| ***Backshore*** | **The coastal area fronted by the shoreline - fore shore - backed by the base of coastal cliff.** | **الشاطئ الخلفي B :** المنطقة الممتدة فيما وراء خط الشاطئ باتجاه اليابس حتى حضيض أقرب جرف للساحل أو من حافة خط الشاطئ (مسطاح الشاطئ) أو ماتعرف بالبرم ***Berm*** حتى أقدام الجرف الساحلي . |
| ***Backwash*** | **Return flow of swash water under influence of gravity.** | **الخضرية (ارتداد الامواج) :** عودة تدفق مياه العجيج بفعل أثر الجاذبية . |
| ***Badland*** | **Rugged land surface of steep slopes, resembling mountaneous areas developed on weak clay formations or clay - rich regolith by fluvial erosion too rapid to permit plant growth and soil formation. (Strahler, N and Strahler, A. H 1978, p. 457).** | **الأرض الوعرة (الحزون) :** أسطح أرضيه وعرة ذات انحدارات شديدة متضمنه مناطق جبلية تطورت فى صخور طينية ضعيفه قطعت بفعل عمليات تعرية نهرية أو فى حطام صخرى غنى بمكونات الطين وعادة ما تتكون على طول امتداد جبهة حافة متراجعه (محمد صبرى محسوب ، ٢٠٠٣ ، ص ٢٢) . |
| ***Bajada*** | **Graded slope that is an alluvial fan or a pediment, extending from mountain base to playa.** | **البهادا :** عبارة عن سطح رسوبى هين أو متوسط الانحدار يتكون من تلاحم اكثر من مروحة فيضيه أو من سطح بيدمنت ، يمتد عند اقدام الجبل باتجاه البلايا .<br>وتتميز بطبقيتها وطوبوغرافيتها المعقدة . |

| | | |
|---|---|---|
| ***Bar*** | A deposit of silt, sand and gravel in a stream, lake or sea that has resulted primarily from processes of sediment movement and deposition in water. | **حاجز شريطى :** ترسبات من الغرين والرمل أو الحصى فى نهر أو بحيرة أو مياه بحرية ضحلة ، نتجت أساسا من عمليات مرتبطة بالترسيب تقوم بها مياه متحركه ومحملة بالرواسب . |
| ***Barrier island*** | Long narrow island, built largely of beach sand and dune sand, parallel with the mainland and separated from it by a lagoon. | **جزيرة حاجزية :** عبارة عن جزيرة طويلة وضيقة بنيت بشكل كبير من رمال الشاطىء ومن رمال الكثبان الرملية الساحلية وتمتد موازية لليابس الرئيسى وتنفصل عنه بواسطة لاجون شاطىء . |
| ***Barrier island coast*** | Coast with broad zone of shallow water off shore (a lagoon) separated from the sea or ocean by a barrier island. | **ساحل حاجز :** ساحل حواجز جزرية يتميز بوجود مياه شاطئية ضحله (لاجون) تنفصل عن البحر أو المحيط بجزيرة حاجزية . |
| ***Barrier reef*** | Coral reef separated from mainland shoreline by a lagoon. | **شعاب حاجزية :** حاجز مرجانى ينفصل عن اليابس الرئيسى بواسطة لاجون أو بواسطة قناة مائية عادة ماتكون ضحلة (راجع المؤلف ، ١٩٩١) . |
| ***Base level*** | The lowest level to which a stroam can cut its bed. It is usually determined by the level of the water body which the stream flows into. | **مستوى القاعدة :** هو المستوى الأدنى الذي تتجه نحوه الانهار وهو عادة مايتمثل فى مستوى سطح البحر كمستوى رئيسى أو مستوى سطح بحيرات أو نهر ضخم بالنسبة لروافده والتى لايمكنها أن تنحت دونه . |

| | | |
|---|---|---|
| ***Beach*** | Thick accumulation of sand, gravel or copples extends from the extreme upper limit of wave action to off shore byond low water mark. The composition and textural properities of beaches vary considerably from locality to locality. The effects marine processes are related to the composition, size and shape of the beach material which in turn determines the slope or gradient of the beach face (Dyrbyshire, et al., 1978, p. 14). | **البلاج :** نطاق من الترسبات الرملية أو الحصوية يتميز بشكل عام بانحداره الهين وامتداده من اقصى نقطة تصلها الامواج حتى مستوى أدنى جزر . وترتبط خصائص ومكونات البلاج وانحداره بالعمليات البحرية . وتختلف خصائصه التكوينية والنسيج الصخرى لمكوناته اختلافا كبيراً من منطقة لأخرى |
| ***Beach drift*** | transport of sand on a beach parallel with a shore line by a succession of land ward and sea ward movements at times when swash approach obliquely. | **انجراف البلاج :** نقل الرمال على البلاج فى حركة موازية لخط الشاطئ مع تتابع حركة المياة تجاه اليابسة وارتدادها تجاه البحر ويحدث ذلك مع وصول مياه العجيج Swash مقتربه من الشاطئ فى شكل منحنى . |
| ***Beach ridges*** | Low ridges of sands extend in succession during progradation of a beach. | **حافات الشاطئ :** حافات ساحلية منخفضة تمتد فى شكل متتابع مع تقدم البلاج باتجاه البحر . |
| ***Berm*** | Low embankment (or flat back shore) on sand beach constructed by swash of breaking waves. | **مسطاح الشاطئ :** عبارة عن شاطئ خلفى يشبه الدرج يتميز باستواء سطحه ونتج عن نحل الامواج وتكسرها مع البلاج . |

***Butte***

Steep sided hill or peak often representing the final remnant of a resistant rock layer in a region of horizontal strata.

**تل خيمى :**
تل بارز يتميز بشدة إنحدار جوانبه غالبا مايمثل البقية المتبقية لطبقة صخرية شديدة المقاومة لعمليات التعرية فى منطقة تتميز بأفقية طبقاتها .

## C

***Calcification***

Accumulation of calcium carbonate in a soil, often producing hard nodules or layers of C.C or calich.

**التكلس :**
تراكم كربونات الكلسيوم فى التربة خاصة فى الافق ***B*** وغالبا ماتكون عقد أو طبقات رقيقه من كربونات الكلسيوم او مايعرف بالكاليش .

***Caliche***

Describes a variety of crusts and hard pans composed of C.C or sodium nitrate. The term also applies to various types of whitish clays (Gardner, J, 1977, p. 516)

**كاليش :**
مصطلح يعنى تكون قشور صلبه من كربونات الكلسيوم أو نترات الصوديوم وتستخدم كذلك فى تحديد أنواع الطين الضارب للون الأبيض .

***Cliff***

Vertical rock wall formed from flat lying resistant layered rocks usually sand stone, limestone, or lava flows.

**الجرف :**
حائط صخرى متقطع وشبه رأسى يتكون من صخور صلبة طبقية تمتد فى وضع أفقى عادة ما تتكون من صخور رملية أو من الحجر الجيرى أو من تدفقات لافية .

***Coastal blowout dune***

High sand dune of the parabolic dune adjacent to a beach, usually with a deep deflation hollow enclosed within the dune ridge.

**كثيب التذرية الساحلى :**
كثيب ضخم ومرتفع من نوع الكثبان الجدوعة ***Parabolic*** متاخم للبلاج يتميز بوجود حفرة تذرية عند حافته .

| | | |
|---|---|---|
| ***Coastal plain*** | **Coastal belt, emerged from beneath the sea as a former contineutal shelf underlain by strata with gentle dip sea ward.** | **السهل الساحلى :** هو النطاق الساحلى الذى يعلو مستوى سطح البحر كرصيف قارى سابق تعلوه طبقات تميل ميلاً خفيفا تجاه البحر . |
| ***Coast line*** | **Zone in which coastal processes operate or having a strong influence.** | **خط الساحل :** هو النطاق الذى تعمل خلاله العمليات البحرية الساحلية أو تكون لها نفوذ قوى به ويمتد خط الساحل عند حضيض أقرب جرف من البحر . |
| ***Coral reef*** | **Rock like accumulation of carbonate mineral secreted by corals and algale in shallow water along a marine shore line.** | **شعاب مرجانية :** تراكمات تشبه الصخر من معادن كربونيه تكونت بواسطة حيوان المرجان والطحالب التى تفرزه فى مياه ضحله على طول خط الشاطئ . |
| ***Cuspate bar*** | **Low coastal sand ridge projecting sea ward in a tooth like form, a form of beach.** | **مسنن شريطى :** عبارة عن حافة رملية تمتد متعامدة على الساحل باتجاه البحر وهى نوع من البلاج . |
| ***Cuspate delta*** | **Delta with a shoreline sharply pointed toward the open water.** | **دلتا مسنن (مسنن دلتاوى) :** دلتا ذات مقدمه شاطئية مدببه باتجاه مياه البحر . |
| ***Cuspate forland*** | **Accumulation of beach ridges projecting seaward in a tooth like on arcuate form, formed by progra-dation.** | **جبهة مسننة :** تراكم لحافة شاطئ تمتد تجاه البحر فى شكل مروحى أو ضرسى أو ضرس نتيجه لتقدم الشاطئ تجاه البحر . |

# D

| Term | Definition | المصطلح |
|---|---|---|
| *Deflation* | Lifting and transport in turbulent suspension by wind of loose particles from dry ground swface. | **التذرية :** رفع ونقل للمفتتات الدقيقه السائبة من سطح مفكك جاف وعادة مايكون نتاج هبوب رياح قوية . |
| *Dendritic pattern* | A network made up of irregularly branching segments that join on another at all angles. | **نمط التصريف الشجرى :** |
| *Drainage basin* | Total land surface occupied by drainage system, bounded by a drainage divide or water shed. | **حوض التصريف النهرى :** |

# E

| Term | Definition | المصطلح |
|---|---|---|
| *Ebb current* | Out ward flow (sea ward) of tidal current. | **تيار مدى مرتد :** يتدفق تجاه البحر في شكل تيار مائى رجعى . |
| *Evaporites* | Class of chemical precipitate sediments and sedementary rocks composed of soluble salts deposited from salt water bodies. | **متبخرات :** ترسيب كيماوى للرواسب والصخور الرسوبيه التي تتكون من أملاح مذابه ترسبت من أجسام مائية ملحية . |

# F

| Term | Definition | المصطلح |
|---|---|---|
| *Fetch* | The distance or area of continuous water surface over which wind waves can be generated. | **مسطح عمليات مائيه :** مسطح مائى تتولد فوقه الأمواج . |

| | | |
|---|---|---|
| ***Fore shore*** | The part of a shorline adjacent to the water body that is influenced directly by the water body. | **الشاطئ الأمامي :** هي المنطقة من الشاطئ الملاصقة للماء مباشرة وتنحصر بين علامتي المد والجزر وتتأثر بشكل مباشر بالبحر . |
| ***Fossiliferous limestone*** | Limestone that contain organic remains. | **حجر جيري حفري :** تحتوي على بقايا عضوية . |
| ***Fringing reef*** | Coral reef directly attached to land with no intervening lagoon of open water. | **إطار مرجاني :** شعاب مرجانية تلاصق اليابس دون وجود فاصل بينهما . |
| **G** | | |
| ***Groin*** | Man made wall or embank ment built out into the water at right angles to the shorline. | **حاجز أمواج :** عقد كحائط متعامد مع خط الشاطئ لحجز الرواسب وحماية الشاطئ من خلال حجزة للرواسب مع إضعاف الانجراف على طول خط الشاطئ . |
| ***Gully*** | A small ravine cut in the ground surface by periodic run off. Intermediate in size between smaller rills and larger stream channel. | **جدول مائي :** يقطع سطح الارض نتيجه للجريان الموسمي وهو وسط بين المسلات ***Rills*** والمجري الكبير وتأخذ قطاعه العرضي حرف ***V*** . |
| **H** | | |
| ***Hazard*** | Events, objects, processes, substances etc. That are perceived to - cause more damage to, or impose more coast on society than the benefits they give | **خطر :** |

| | | |
|---|---|---|
| ***Hydrophyte*** | | **نبات محب للماء :** نبات يعيش فى الماء أو فى ظروف مشبعة بالماء فى منطقة المجموع الجذرى . |

# I

| | | |
|---|---|---|
| ***Infiltration*** | The process by which water moves into and through a soil or sediment. | **التشرب :** عملية يتحرك خلالها الماء فى التربه أو الرواسب . |
| ***Inselberg*** | Aprominent steep sided hill rising above a generally flat erosion surface. The insel berg is thought to be a remnant of a previous land surface. | **جبل جزرى :** تل أو جبل ذو جوانب شديده الانحدار يبرز وسط سهل تحاتى يتميز بالاستواء ويعتقد بأن الجبل الجزرى يمكن أن يكون بقية متبقية لسطح سابق . |
| ***Lacustrine*** | Produced by or related to lakes as in lacustrine deposits. | **بحيرى :** نتاج بحيرة أو مرتبط بالبحيرة مثل الرواسب البحيرية والتى تعد رواسب تم ترسبها فى حوض البحيرة . |
| ***Leaching*** | The process of washing or draining by percolation of water. In the process, material is picked up and carried or dissolved and carried. | **غسل :** عملية غسل أو تصريف بفعل تخلل المياه . وفيها يتم تلتقط المفتتات (الجزئيات) وتحمل أو تذاب وتنقل بالاذابه . |

| | | |
|---|---|---|
| *Lichen* | A small, low plant that grows on trees, bare rock surfaces and soil. It is represents a symbiotic combination of algae and fungi that occur in several forms. | **الأشنات :** نبات صغير ومنخفض ينمو على الاشجار والصخور العاديه والتربه ويمثل حالة مشتركه بين الطحالب والفطريات ويأخذ أشكالا عديده . |
| *Littoral* | Relating to the shore or near shore. It include that part of the bottom that is subject to light penetration. | **شاطئ :** يتمثل فى المنطقة الضحله التى يتغلغل خلالها الضوء . |
| *Loam* | A soil consisting of an equally shared mixture of sand, silt and clay. | **لوم :** تربه تتكون من خليط متماثل - متساوى - من الرمل والسلت (الغرين) والطين . |
| *Longshore drift* | The movement of water along a shore line. Sometimes called littoral drift, long shore drift is responsible for the transport of sediment along the shore. It is the product of wave action against the shore tidal effects. | **الإزاحة الشاطئية :** حركة الماء على طول خط الشاطئ . أحيانا يسمى إزاحة جرف للرواسب على طول خط الشاطئ وهذه نتاج فعل الأمواج على الشاطئ وكذلك بسبب المد وفى بعض المواضع بسبب الأنهار . |

## N

| | | |
|---|---|---|
| *Neap tide* | The tide that occurs at the time when the moon and sun are not in conjunction or opposition. It is usually 10-30% less than the mean tidal range. | **المد والجزر العادى** |

| | | |
|---|---|---|
| *Nutrient* | Any element or compound that nouishes or contributes to the growth of an organisms. | **عنصر تغذية :** |
| **O** | | |
| *Offshore* | That part of beach lying in the zone of shoaling waves and below the level of low tide. | **الشاطئ الخارجي :** وهو الجـزء من الشـاطئ الواقع فى منطقـة الأمواج أسفل مسـتوى الجزر |
| *Offshore bar* | Low bar of sand in the offshore region of a beach. | **حاجز الشاطئ الخارجي :** منخـــفض رملى يوجـــد فى الشاطئ الخارجى . |
| **P** | | |
| *Playa* | Flat land surface under lain by fine sediments or evaporite minerals deposited from shallow lake waters in a dry climate in the floor of a closed topographic depression. | **البلايا :** سطح مستو يتكون من رواسب ناعمة ومعادن متبخرات ترسبت من مياه بحيرة ضحله فى مناخ جاف داخل منخفض طوبوغرافى مغلق . |
| *Primary coast* | A category in a classification of coasts. P.c are those that dont display pronounced effects of marine erosional and depositional processes but do show the effects of land erosion and deposition. | **الساحل الأولى :** يعكس ظروف قارية نحتيـه أو ارسـابيه اكـثر من كونه يعكس أثر التعرية البحرية . |

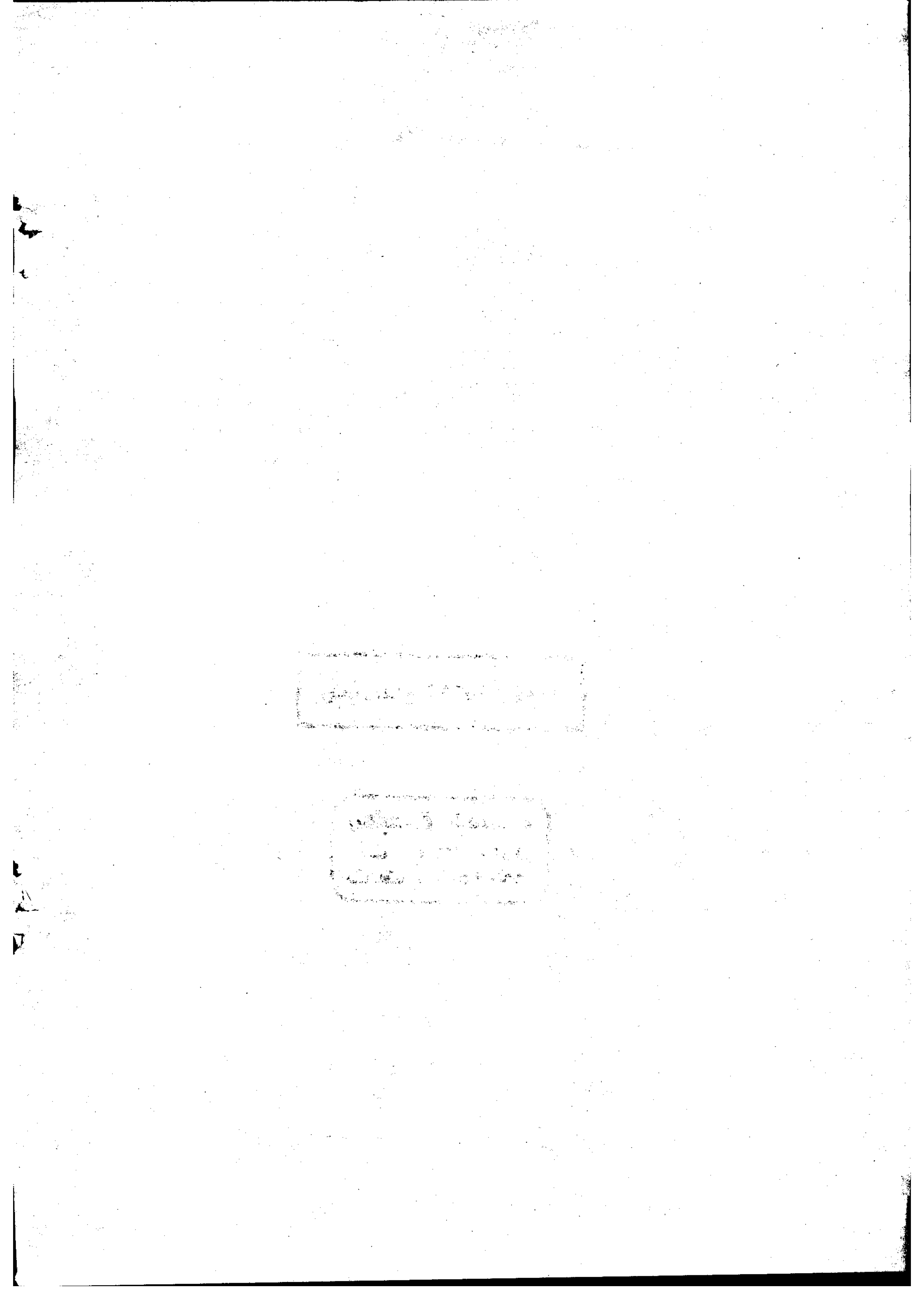
## R

| Term | Definition | Arabic |
|---|---|---|
| ***Rip current*** | A strong current of water moving sea ward from shore line. It is strongest close to the bottom and represents the sea ward transport of water brought to the shore by wave action. | **تيارشقى :** تيار قوى من المياه المرتده جهة البحر يزداد قوه عند القاع . |

## S

| Term | Definition | Arabic |
|---|---|---|
| ***Salinity*** | Used as a measure of the concentration of total dissolved solids in water. | **الملوحة:** نسبة الأملاح الذائبة إلى الماء. |
| ***Salinization*** | A process occurring in soils as a result of evaporation of surface water and soil moister and the consequent deposition of a residue of salt in the soil. | **التملح :** عملية تحدث فى التربه كنتيجه لتبخر الماء من سطح التربه مما يؤدى إلى ترسيب الأملاح وتركيزها فى التربه . |
| ***Shoreline*** | The line of intersection of the land with the occean or other major water body. | **خط الشاطئ :** خط التماس بين اليابس والماء . |
| ***Storm surges*** | Large pile-ups or series of waves caused by severe storms. Storm surges cause great increases in coastal water levels and result in coastal flooding in low lying areas. | **جشنات بحريه :** سلسلة من الامواج العنيفة الناتجه عن عواصف قويه جداً لها آثار مدمرة للسواحل . |

| | | |
|---|---|---|
| *Swash mark* | A thin wavy line of fine sand and organic material produced by the rush of a wave up a beach. the swash mark represents the farthest inland progress of the wave. | **علامة المجيج :** خطوط موجيه من رمال ناعمة ومواد عضويه نتجت عن إندفاع الامواج تجاه البلاج (الشاطئ) . |
| **T** | | |
| *Tidal wave* | Relatively small waves produced by the movement of incoming and outgoing tides. Should not be used for the large waves produced by storms and earth equakes. | **أمواج مديه :** أمواج صغيره نسبياً تنتج عن حركة المد والجزر . |
| **W** | | |
| *Wave-cut-platform* | A terrace, usually in bedrock, cut by the action of breaking waves against sea cliff. | **رصيف نحت الأمواج :** مدرج من صخور الأساس نحت بفعل تكسر الأمواج على وجه الجرف الساحلى . |
| **X** | | |
| *Xerophytes* | Plants that are capable of living in dry conditions. | **نباتات جفافية :** قادرة على تحمل المياه في طرف الجفاف . |



رقم الإيداع: ١٥٦١٣ / ٢٠٠٤

مطبعة الإسراء
ت : ٥٦٢٣٨٣٢٢
ت.ف : ٥٦٠٤٥٠٠